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## THE SUGAR CANE.

By C. A. BARBER, M.A., F.L.S. (*late Superintendent of Agriculture of the Leeward Islands*).

IN the year 1892 the world's production of sugar was estimated at close on fifty million hundredweight. It may be broadly stated that of this quantity half is obtained from the sugar cane grown in the tropics, and half is extracted from the beet-root of the temperate region. Sugar is also produced from sorghum, the maple, several palms, and from starch; but these sources may be neglected in a general estimate.

The consumption of sugar varies very greatly in different countries. Thus it is calculated that the inhabitants of Great Britain and Ireland require seventy-two pounds per head annually, the quantities used by other countries being fifty-two pounds in the United States, twenty-five pounds in France, and only seventeen pounds in Germany. To us, then, as a nation, the physiological action of sugar upon the system is a matter of considerable importance. When first introduced into Europe it played a prominent part in medicine, and it would be interesting to turn up the old medical works to see what it was used for.

To-day it is a conspicuous article in our diet, and its true value as a nutritive substance is becoming more and more widely recognized. Interesting experiments have quite recently been carried out in schools, as to the effect of adding several ounces of sugar daily to the diet of the boys; the result being that they are found to be capable of performing an increased amount of muscular exercise. Be that as it may, the effect of unlimited quantities of sugar cane juice upon the labourers on West Indian estates is seen every time the crop is reaped. However weak and starved-looking the negroes are when the first canes are cut, they rapidly improve in condition; and, although the labour in the field is exceedingly heavy, towards the end of crop-time they are conspicuously sleek and well-fed. They are daily met carrying home a fine cane or two upon their heads as perquisites.

Wray, a writer upon the sugar cane, asserts that it has been absolutely proved that man can not only exist but become stout and healthy on sugar, and sugar alone. He instances the case of the crew of a ship bringing home a cargo of sugar from the tropics. By calms and disasters, provisions ran short and were at last absolutely exhausted. The starving crew had recourse to their cargo of sugar. This not only sustained the men, but actually cured them of the scurvy which had made sad havoc among them. Supplied by this providential food, they reached their port in safety.

FIG. 1.—Two Joints of a Caledonian Queen Cane from St. Kitts.

Of the main sources of sugar supply, the beet-root was first grown for this purpose barely one hundred years ago, while the cultivation of the cane is known to have been carried on before the Christian era. We know that several centuries before Christ the cane juice was sucked or expressed in India, although the art of making solid sugar seems to have been discovered much later. The plant is not known to occur wild in any part of the world—a fact which, of itself, points to great antiquity—and it is accordingly difficult to determine its original habitat. The name is, however, derived from the Sanscrit *Sarkura*, and more recently the Arab *Sukhar*; and from this and other facts, it is deemed likely that the plant was originally obtained from the coast of India north of the Indian Ocean, or from the mountains of Polynesia in the neighbourhood of the tropics.

Unknown to the ancient Jews, who used honey for the sweetening of their food, it was first used in Europe by Alexander the Great, who, in 327 B.C., brought it as one of his trophies from the East. Thus Pliny relates that Alexander found "a remarkable kind of reed, growing in India, which produced a sort of honey without the assistance of bees."

The cultivation was introduced into Persia about 500 A.D., and great attention was at once paid to the manufacture of this valuable substance. We read now for the

first time of really fine white sugar—"axe-hewn" as it was called. This was obtained by repeatedly boiling, straining, and refining with milk. The Arabs obtained the plant on their conquest of Persia, and carried it westwards with them. In 750 A.D., it is stated that the most fertile land in Egypt was almost entirely under sugar cultivation, and the manufacture of sugar increased largely. It is said that, at marriages and festivals at the Arabian court in Egypt, quantities of sugar were consumed, on individual occasions amounting, in our reckoning, to from sixty-seven to seventy-one tons—the annual yield of a small estate. About the same time it was introduced into Spain by the Moors.

Next in its westward course the cane was carried to the Canaries, while in 1493 Columbus took it to San Domingo, where it increased so remarkably as to become in after years the main cultivation of the West Indian Islands. And so it continues to be at the present day, after the lapse of four centuries.

The sugar cane is now cultivated within the tropics in both hemispheres, especially in the West Indies, Java, Mauritius, the Sandwich Islands; also in Egypt, Queensland and the Southern United States. In America its northern limit is 32°, in China 30°, while it is grown in individual gardens in Spain as far north as 37° of latitude.

There is no more beautiful sight in the tropics than a sea-girt coast clothed by cane fields. In some islands—for example, St. Kitts and Barbados—there is no other cultivation, if one omits the smaller patches of vegetables grown for local consumption. In all directions one sees field after field of canes in every stage of growth, from the young plants just emerging from the black soil to the waving feathery "arrows" of the mature plants, with here and there the tall chimney of the half-hidden cane mills. The feeling of novelty experienced on driving for the first time through these gigantic grass fields—for the cane is a grass—is not easily forgotten. Shut in by an avenue of reed-like stems and waving leaves, one receives a lasting impression of the luxuriance of tropical agriculture; and, while fighting one's way into the cane fields in search of the various pests by which the plants are just now so abundantly attacked, one sympathizes with the ants at home which may be seen climbing about among the grass stalks.

The sugar cane, as already mentioned, belongs to the order of grasses—the Gramineæ of botanists. The following is a brief botanical description. Each plant consists at crop-time of a much-branched underground root-stock, which gives off a tangled mass of thread-like roots below, and a bunch of from ten to eighteen aërial shoots above. The latter, from six to fifteen feet in height, may be roughly divided into two portions—the lower part, from which the leaves have dropped or are readily detachable, called the "cane," and the upper younger part or "top." The canes are cylindrical and jointed, and of various shades of green, yellow and purple, sometimes variegated with beautiful stripes. Those of ordinary cultivated varieties are from one to two inches in diameter, with joints from one to eight or nine inches in length. The broad, strap-shaped leaves arise in two opposite rows from the cane, one from each node or knot. They are from three to six feet in length, with a diameter of one to three inches. Each leaf is divided into two parts—a lower shorter portion, the sheath, usually of the colour of parchment, which completely embraces the stem and is attached all round the node, and a much thinner flat blade of bright green, with a white mid-rib, or "bone," in the centre and a finely-toothed edge. The sheath is in some kinds thickly covered on the outside with long siliceous hairs, which readily penetrate the skin, while very severe cuts are sometimes received from the saw-like edges of the blade. In the axil of each leaf, at the joint, and therefore completely protected by the sheath, is a solitary bud. Any bud upon the plant may be used for propagation, and will, under suitable conditions, reproduce the whole plant. At the joint, and on each side of the bud, is a zone of several rows of small circular prominences, which completely encircles the cane. These are the adventitious roots, which in contact with damp earth at once develop and cause the bud to burst into a leafy shoot. In the ordinary upright canes these roots remain dormant, but when canes are beaten down by high winds, or bend by their own weight, they frequently become fixed to the ground. A cane dug out of the mud in Dominica was found to be nineteen feet in length and extensively rooted at every joint. At the upper part of each joint, just below the insertion of the leaf-sheath, there is usually a ring of white waxy substance coating the surface of the cane. This is especially well marked in Figs. 1 and 2.

FIG. 2.—The "Top" of a Bourbon Cane from St. Kitts, attacked by "Borers."

The cane, or lower part of the aërial shoot, is of importance, as from it alone is obtained the sugary juice. It is solid, as contrasted with the hollow bamboo; the exterior, or "rind," is hard enough to turn the edge of an ordinary penknife, but the interior is soft and juicy. At maturity the leaves have fallen off. Two joints of a Caledonian Queen cane are shown in Fig. 1, where may be seen the sharp ridge left by the broken-off leaf-sheath, the buds on opposite sides of the stem, the zone of dormant roots, and the waxy ring.

The upper part of the shoot, or "top," is made up of immature joints. These are much shorter than in the cane and contain no sugar, or very little. The leaves are all still attached and form a beautiful green plume.

This part of the cane-plant is much attacked by caterpillars of different kinds. In the illustration, Fig. 2, four leaves have been stripped off, showing the ragged bases from which the sheaths have been torn; two buds are visible, the two alternating ones being on the opposite side of the stem. The root zone at the lower, and the waxy layer at the upper part of each joint, are very clearly shown. The upper joints still retain their leaves. In the figure, the "top" is severely attacked by the "moth-borer" (*Diatræa saccharalis*), the ravages of whose caterpillars are only too plain.

The sugar cane is usually reaped before it flowers. The solid stems are carried to the mill to be crushed, while the tops are saved for planting next year's crop, and the surplus used as food for the cattle. But if, instead of being cut, the plant is allowed to grow on for a few weeks, each shoot will throw up an inflorescence or "arrow." Although the sugar cane is vegetatively reproduced in ordinary cultivation, and seed is not used, the flowering of the plant is a matter of some consequence in agriculture, as thereby the yield of juice is perceptibly diminished. In this matter there is

great diversity of opinion among planters. In some places the appearance of much arrowing among the canes is looked upon with indifference, while in others it is regarded with apprehension; and again, it is found that the varieties of cane behave differently. The Caledonian Queen, for instance, is much more prone to arrow before reaping than the Otaheite, as it reaches maturity sooner.

For those not immediately interested in the yield of juice, the inflorescence of the sugar cane is a very beautiful object indeed, and few sights in the tropics are more striking than a field of arrowing canes. A considerable trade might doubtless spring up if the heads were cut and prepared so as to prevent the scattering of the flowers. Each inflorescence is a pyramidal mass of feathery florets, supported by a shaft or stalk from four to six feet long.

It will be of interest briefly to trace the growth of the cane-plant from sowing to reaping. The method of propagation universally adopted in the field is that of burying in the earth pieces of the stem bearing undamaged buds, which are then called "plants." Such is the vitality of the plant that the buds thus treated rapidly shoot out, giving off roots at their bases, and becoming independent plants almost before the decay of the piece of parent stem. A young shoot is drawn still adhering to the planted piece (Fig. 4). The part of the stem chosen for planting is usually the top, although almost any part with sound buds would do. The advantages of choosing this part are that there is comparatively little sugar in it, and therefore there is no loss in the quantity of sugar obtained from the crop; the buds are closer together, and there is thus a greater chance of obtaining a good stand; and, lastly, the buds of this portion of the cane are probably in a more plastic condition. Not infrequently, however, the canes themselves are cut up and laid down, sometimes in long furrows, as in the United States, at other times freely scattered over the soil and covered up, as in parts of India.

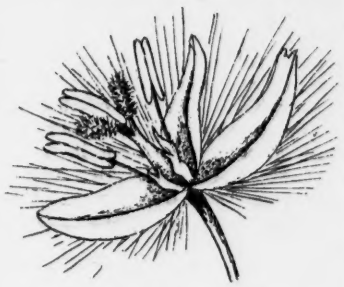

FIG. 3.—Floret of Sugar Cane, greatly magnified. (After Morris.)

When the crop is reaped in the West Indies, before the canes are carted to the mill, the tops are cut off and left upon the field. A separate body of workers come round, collect the undiseased tops, and trim them for planting. Pieces are selected from six to eight inches in length, including on an average three buds. These are neatly arranged in baskets and carried to the liming tank. Here they are immersed in a mixture of lime and water for about twelve hours, to free them from unobserved caterpillars, etc.; and it is quite surprising what a number of these creatures are seen shortly afterwards wriggling on the surface of the water. After immersion they are spread out in the sun for an hour or so to dry, and are then ready for planting.

The soil of cane fields is usually kept in a fine state of tilth to the depth of nine inches or more. This is greatly facilitated by the presence of quantities of decaying vegetable matter in the shape of the cast-off leaves and dead roots of the previous crop of canes.

After the field has been cleared of canes for the mill, of tops for the plants and fodder for the cattle, and finally of the diseased pieces which have been cast aside in the bustle of cane-cutting, the new cultivation is commenced. The whole field is still covered by a thick layer of dead leaves or "vowra." The first operation is the "ranging" of the vowra, or drawing it over the stumps of the canes just reaped. A gang of labourers is then told off to dig a series of parallel furrows, about five feet apart, throughout the entire field. The furrows are dug between the rows of last year's stumps, and the soil is heaped upon the masses of vowra. The ridges thus formed, or "banks," are broken up by a plough after a few weeks, and the decomposition of the vegetable matter contained adds to the humus, so necessary to the growth of the canes.

After the furrows are prepared the "cross-holing" is done. A few dexterous strokes of the hoe—which is almost the only agricultural implement in the negro's hands—build a narrow ridge across the furrow, to be followed by another and another till the whole field is honeycombed with a multitude of square pits. The centres of these "cane-holes" are about five feet by five apart, although the distance varies with the locality and the kind of cane. The cross-holing is intended to collect the rain and supply the young plants with moisture, and consequently, in wet regions, they are dispensed with, the furrows becoming rather a system of drains for carrying off the superfluous water—canes cannot stand stagnant water.

It is usual to add to each hole a small supply of stable manure, "pen-manure" as it is called; but the quantity available is rarely sufficient to provide for the entire acreage of "plant canes" every year. The fields are treated in succession, so that each has its supply of pen-manure once every few years.

The pieces of canes selected for propagation, or "plants," are pressed down in a slanting position in the bed of the cane-hole. In a few weeks the tender green blades appear, and the cane growth has commenced (see Fig. 4). While the young plants do not cover the ground constant weeding is necessary, and, in the case of lighter soils, a "cultivator" may be driven between the rows. But the dense mass of cane leaves quickly covers the ground and effectually strangles any unbidden growths.

It is necessary from the first to be on the look-out for dying shoots or "dead-hearts." These are shoots which rather suddenly turn brown and die. They are the sign of the progress of the moth-borer, which works its way upwards till the growing apex is reached, when all growth is checked and the part commences to rot. All dead-hearts are persistently cut out and destroyed, for fear that the caterpillars should turn to moths and spread the disease.

Meanwhile the plants are growing apace. Instead of one or two shoots from each cane-hole, we now see six or ten, the number constantly increasing with the age of the plant. The shoots in the "bunches" grow for some months before any solid "canes" are formed. This depends to a very large extent upon the season. If the desired rain is too long withheld, no cane is formed at all by crop-time, and the field is not worth cutting. This is, however, not frequently the case. Although the seasons vary considerably, the rainfall in the tropics is a fairly reliable factor in cultivation. There are, of course, "dry" islands, generally such as have no great elevation. Antigua, for instance, with a maximum height of some one thousand three hundred feet, is liable to droughts. One such occurred in 1894. The average rainfall may be taken as from forty-five to fifty inches per annum. On one estate, in the windward part of the island, nine or ten inches were recorded in 1894 in as many months, a quantity with no appreciable effect in the fierce heat of the tropical sun. It is not surprising, then, that even the cactus began to wither, and every cane-plant upon the estate died.

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The rainfall is very carefully studied in the drier sugar-growing islands. Certain stages of the plant's growth require a much greater rainfall than others, while near crop-time it is preferable to have dry weather for the ripening of the canes. The absence of rain during the growing season appears also to be a direct encouragement to nearly all the pests which attack the cane-plant, and this has been markedly so during the last few years in the West Indian plantations.

We have thus traced the cane-plant in its growth from the dormant bud to the full-grown "bunch," with its knotted root-stock and mass of solid upright canes. In very few islands is the growth of the cane confined to one season. Where the soil is not too light, and a fair amount of rain is obtainable, it is usual to allow the plants, after being cut down, to shoot out again or "ratoon." The expenses of cultivation which, in the northern West Indian Islands at any rate, is largely performed by hand, are so great that the economy of ratooning is at once evident. Unless the conditions are very favourable, however, this system of ratooning cannot be employed for more than two or three years. As remarkable exceptions, fields may be seen in Nevis of ratoons of ten to fifteen years' standing. In Dominica again, where the cultivation is in a very backward condition, on one estate, whose fields are occasionally swept by the fertilizing waters of a turbulent river, it is impossible to determine when the fields were last planted—probably twenty-eight or thirty years ago. Such is the fertility of the soil, kept up by the alluvial deposits of the overflowing river, that year after year the cane may be reaped at a profit, and shows no tendency towards dying out. In the neighbouring island of St. Kitts, which is dry and possesses an exceedingly light soil, by way of contrast, only certain fields can be successfully ratooned at all, and second ratoons are a rarity.

FIG. 4.—A Young Cane Shoot still attached to the planted piece. (After Lock.)

The reaping of "ratoons" and "plant canes" is identical. A gang of negro labourers is turned into the field, armed with cutlasses—heavy iron blades a couple of feet long and broad in proportion, fastened to a short wooden handle, to give a firm grip. A single blow severs the cane low down, and a second cuts off the top. The cut canes are rapidly collected into bundles and tied together with wisps made of the strong green leaves.

The bundles are hurled up and stacked into the lumbering ox- or mule-drays, which crash along the lanes to the mill-yard, amid the shouts of the drivers and the cracking of whips. The negro is nothing if not noisy. Each load is thrown in a heap on the ground near the mill, and when thirty or forty have been deposited the "mill-gang" start their work.

The canes are placed end-wise between massive iron rollers, made to revolve by powerful machinery. The canes are thoroughly crushed, a mere residue of fibre emerging from the rollers and streams of dirty juice escaping below. The cane-fibre, or "megass," is quickly carried away in baskets and spread in the hot mill-yard to dry. When quite dry—a matter of three or four hours in the burning sun—it is collected into heaps for future use. It supplies the fuel for the boiling-house, and it is difficult to understand how it could be replaced in the absence of all trees and the costliness of imported coal.

It would occupy too much space to follow all the details of the "boiling-house." Many are the processes through which the juice of the cane passes before it is changed to the beautiful brown crystals or white cubes which we purchase at the stores, or the rum bearing the Jamaica brand. The processes, indeed, are many and complicated, but the principle is the same as that by which the Persians many centuries ago produced their "axe-hewn" product. After "tempering" with lime and boiling down, the crude juice is run into flat wooden troughs to cool. Here it sets into a dark-brown mass of wet crystals. By rapidly rotating these in "centrifugals" the molasses present is driven out, and a refined product obtained which is fit for the table.

The West Indian plantations, with which the present article has mainly dealt, are at present in a very depressed condition. The energetic competition of the beet-growing European countries, rendered more formidable by enormous bounties, has reduced the margin of profit to the narrowest limit. Add to this the fact that diseases of a new and severe type have recently made their appearance in the cane fields, and the outlook becomes one of gloom. It is, indeed, at the present moment questionable whether the cultivation of the cane in these beautiful and smiling islands can be continued. It depends to a large extent upon the beet bounties. If the people of France and Germany can support the heavy taxation which has been

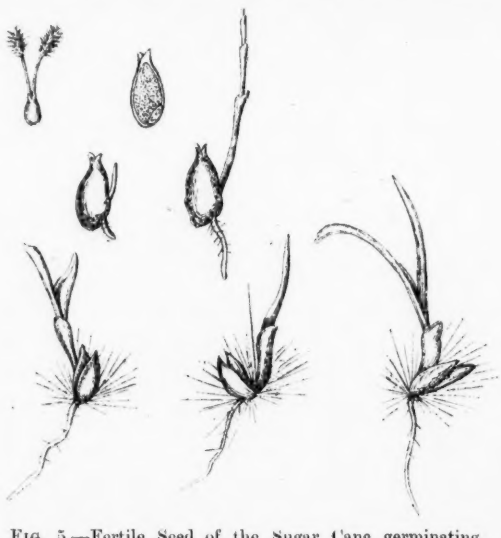

FIG. 5.—Fertile Seed of the Sugar Cane germinating. (After Morris.)

recently suggested, the whole cultivation of the cane and manufacture of its product will need revision.

The question of cane diseases has engrossed much attention of late years. Added to the depredations of insects, which have been known for centuries, fungous pests of a

much more deadly character have made their appearance. Of the many canes under cultivation in the West Indies, the variety usually grown, the Otaheite or Bourbon, is much more severely attacked than some others. There are what appear to be "immune" canes; and one immediate remedy, which has been extensively adopted in St. Kitts and Barbados, is the substitution for the Otaheite of some such cane as the Caledonian Queen.

A great stride has been taken during recent years in another direction. The canes have been propagated from time immemorial by vegetative means, *i.e.*, by putting in pieces of the parent plant, so much so that the fact had apparently been lost sight of that the seed of the arrow is occasionally fertile (Fig. 5). The discovery of the possibility of raising canes from seed is a matter of recent years; and it is hoped by this means to reconstitute the plant, to impart to it a vigour and capacity for resisting disease, and at the same time to increase its sugar-producing properties.

But the path is long and laborious; the obtaining of fertile seed by the crossing of varieties is a matter of no ordinary difficulty, and, once obtained, two years must be passed through before the first canes can be reaped and tested. The vast majority of seedlings thus raised are of comparatively little value, and it is only here and there that one is found which is considered worthy of further trials. Then it has to run the gauntlet of diseases, besides entering into competition with the most approved sugar-producing varieties—the products of selection acting through twenty centuries. Trials have, however, been conducted in many places—Java, Mauritius, Barbados, and Demerara—and the laborious work of Prof. Harrison in the two last-named colonies is a monument of patient and scientific application. With continued experiments of this character, an improvement is certain, judging by what has been done in other cultivations by seminal selection; but the tedious nature of the operation will of itself serve to deter other colonies, less fully equipped with the means of carrying on the experiments, from proceeding with this important work.

## SPECTRUM ANALYSIS.—I.

By J. J. STEWART, B.A.Cantab., B.Sc.Lond.

WHEN sunlight passes through a prism or wedge-shaped piece of transparent substance it is bent out of its course; and if the source of light is a narrow slit—for example, if the light from the sun is made to pass through a small opening in a shutter, the beam of light is spread out after passing through the prism, and if it is received on a screen the image of the slit will consist of a broad band of various colours, red at one end and blue or violet at the other. This bright and many-hued strip is the solar spectrum, and its origin is due to the fact that the amount of bending or refraction which takes place on the passage of light through a prism depends on the colour of the light. Blue light is more refrangible than red, *i.e.*, it is farther bent from its original course, and, therefore, shines on a different part of the screen from that which is illuminated by the red rays. The splitting up of the rays which occurs on the transmission of light through a prism shows that white light is of a composite nature—that is to say, it is made up of rays which differ in colour and refrangibility.

If sunlight be admitted through a small hole in a shutter, so as to fall on a prism placed with its refracting edge horizontal and its base uppermost, the light will be refracted and bent upwards, and may be received on a screen placed at a distance. Now, if the prism is gradually turned round an axis passing through the centre of the prism, and parallel to the refracting edge, so that the coloured spectrum produced is more and more bent downwards, and moves down the screen as the prism is turned, it will be found that at a certain point in the rotation the spectrum becomes stationary; and on continuing the rotation of the prism in the same direction, the image begins to ascend and gets higher and higher on the screen. The position of the prism when, after descending, the coloured image of the sun turns and begins to go upward, is called the position of *minimum deviation*. For that particular position the rays are least deviated from their original course, and they make equal angles with the faces of the prism at incidence and at emergence—in other words, the rays pass symmetrically through the prism.

That white light is made up of rays of different colour and refrangibility was first proved by Sir Isaac Newton. He also showed that lights which differ in colour differ also in refrangibility. By painting an oblong piece of black paper with red on one half and blue on the other, and then viewing the paper when thus coloured through a prism, he found that the light reflected from the blue half was more refracted than that from the red. Placing the paper opposite a window, and looking at it through a prism with its refracting angle downwards, so that the rays were bent upwards, he observed that the blue was lifted higher than the red. When the angle of the prism was pointed upwards the rays were deflected downwards, and the blue were bent lower than the red. In both positions the light from the blue half of the paper was more refracted than that from the red.

The prismatic spectrum is now observed and investigated by means of the spectroscope. Light is allowed to fall on a narrow slit placed at the end of a telescope tube; at the other end of the tube an achromatic lens is fixed at a distance from the slit which is equal to its focal length, so that when the light leaves the lens it consists of a bundle of parallel rays. This part of the apparatus is called a collimator. On a movable horizontal table a prism is placed, and the parallel rays from the collimator are made to fall upon it. They are thus refracted and are then observed through a telescope. The spectrum is brought to a focus by the object glass of the observing telescope, and is then viewed through the eye-piece. Both the collimator and the telescope are attached to a graduated circle, and the telescope is capable of motion round this; it can be fixed in any desired position, and this position can then be read off on verniers attached to the telescope and moving round on the graduated circle. The spreading out of a beam of light into a coloured band, owing to the varying refrangibilities of the component rays, is called dispersion. As in the spectroscope the rays leave the collimator parallel to each other, they are dispersed in the prism, and on leaving the prism there is a beam of red light with a beam of blue light at a distance from it, the red rays being parallel to each other, though inclined to the blue. The yellow and green rays come between, the rays of each colour being parallel amongst themselves. The red rays are thus brought to a focus by the observing telescope at a definite point, and the blue rays at a neighbouring but different point. Thus a pure spectrum may be obtained—that is, one in which the different colours do not overlap. The position of minimum deviation is found in this instrument by turning the prism round by moving its stand till the light is less and less deviated, and following it round with the telescope, when at length a position is reached in which, on further movement of the prism, the image of the spectrum in the

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telescope begins to move in the opposite direction. This is the position of minimum deviation, and any motion of the prism in either direction will increase the deviation. The telescope is now clamped in its position and the reading of the vernier on the graduated circle taken. The direct reading of the slit is taken by turning the telescope to view it when the intervening prism is removed. The difference between this last reading and the former is the angle of minimum deviation. Observations are generally made with the prism in the minimum deviation position, for this position is a readily recoverable one, and observations at different times and in different instruments can then be compared with each other.

The distance between the red end and the violet end of the spectrum is called the dispersion, and this depends on the nature of the material forming the prism. The amount of minimum deviation for a given ray depends on the index of refraction of the material of the prism.

When monochromatic light is used to illuminate the slit—for example, the yellow light given out by a spirit-lamp with a salted wick, or by a Bunsen burner in which a lump of salt is heated—instead of a wide coloured spectrum, a narrow image of the slit is obtained, of one colour only, which would be yellow in the above instance. By observing the minimum deviation in this case, we obtain its value for certain yellow rays, and when a prism of another substance is employed, a different deviation for these same rays is got, and hence, when the angles of the prisms are known, the indices of refraction of the different substances can be compared. The refraction caused in light when it passes through a prism is due to the difference of the velocity of light through air, and through the substance of the transparent medium forming the prism. If this medium consists of a block with parallel faces, and the light falls perpendicularly upon it, retardation merely ensues, the light proceeding in the same line after passing through as before, but if the light falls obliquely it is bent in the transparent slab at an angle to its first direction, and on passing out proceeds in a line parallel with its original direction, but displaced through a certain distance, depending on the thickness and the refracting power of the slab. When the refracting substance has faces inclined at an angle, bending of the rays occurs both on entering and leaving it, and we have the phenomena observed with prisms. It is the rays which have the shortest wave-length whose velocity is most altered in the prism; these are the rays of violet light. Thus violet light is most retarded—that is, it is the most refrangible, its rays being the furthest deflected from their original direction. Of the rays forming the visible spectrum, those possessing the longest wave-length and forming red light are the least bent. It is pretty certain that the velocity of all the rays from the violet to the red is the same in the free ether of space. Now the velocity is equal to the product of the frequency (or the number of vibrations per second) and the wave-length; therefore, these two quantities, which remain unaltered during the passage of light through space, change, one or both of them on the passage of the light through dense matter. As the vibration in the transparent medium is excited by that in the incident light, its period is likely to be the same, so that it is probably the wave-length and not the frequency which changes as the light passes through the prism. Experiment shows that the wave-length of red light at one end of the visible spectrum is about twice as great as that of violet light at the other. The range of the vibrations to which our eyes are sensitive is thus about an octave. The red waves go through nearly four hundred millions of millions of vibrations per second, while the violet vibrate about seven hundred and sixty million million times per second—that is, about twice as fast.

Solids and liquids, when raised to such a temperature that they become white hot and luminous, give as a rule a continuous spectrum—that is, one in which all the visible rays are represented, from the dark red, right on through the spectrum to the extreme violet. Gases, on the other hand, when heated to incandescence and viewed through a spectroscope, exhibit a spectrum which is made up of a few or many bright lines on a dark background. The number and position of these lines depend on the nature and condition of the gas. One of the simplest cases of gas spectra is that referred to above, obtained from the salted flame. Here the incandescent gas is the vapour of the element sodium, and at ordinary pressures, and at the temperature of the Bunsen flame, its spectrum consists of two yellow lines very close together. If the resolving power of the spectroscope is small, these may appear as one line. By special methods of investigation, Mr. Michelson in America has shown that each of these yellow lines in the spectrum of sodium is made up of several very close together, but under all ordinary observation they appear as two, or one double line.

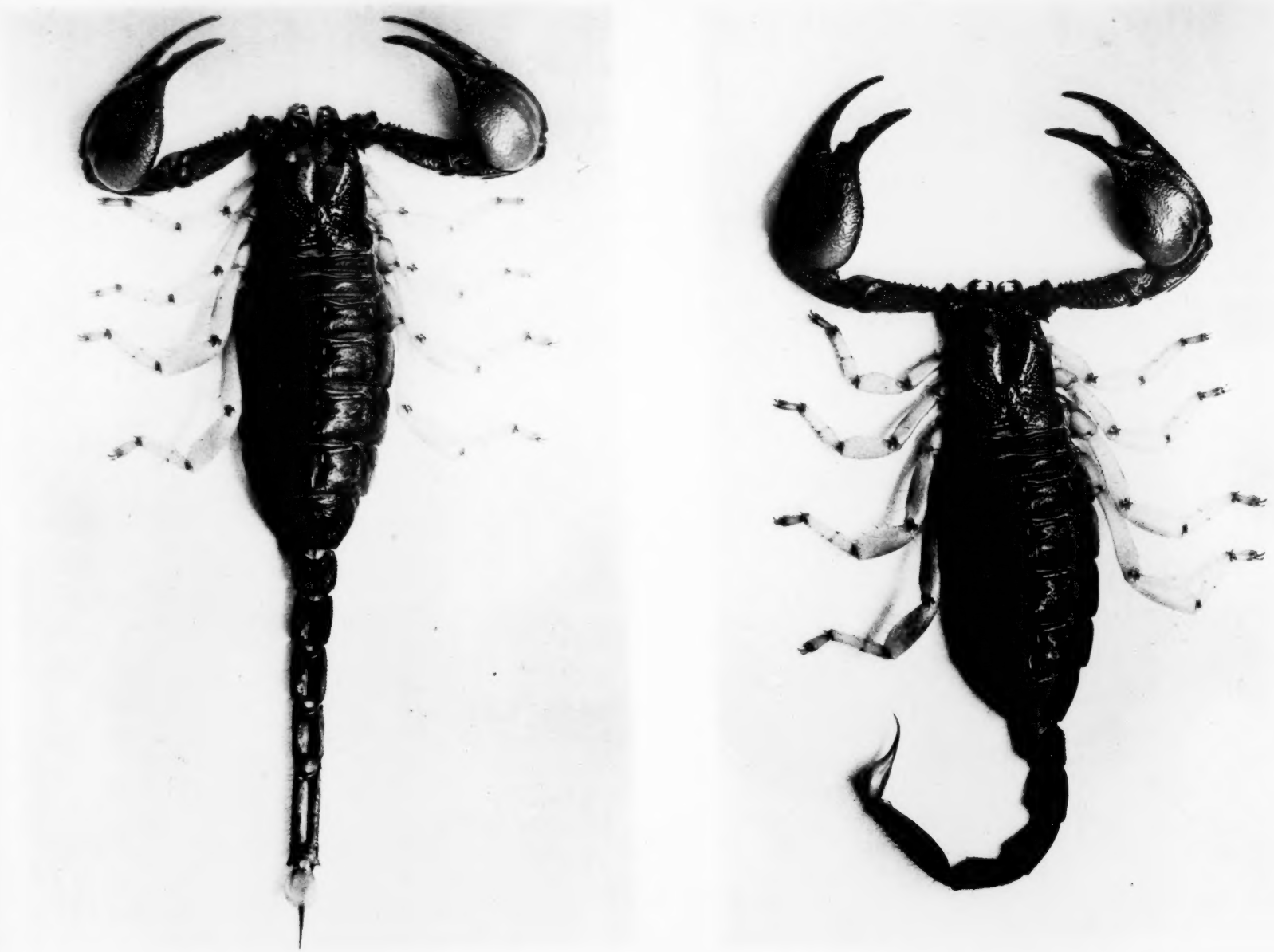
It can be readily understood why the spectrum of a gas differs from that of glowing solids, for a gas consists of molecules existing apart from each other and with a distance between, these molecules being in rapid motion and frequently coming into collision, but during the greater part of their course being free from contact with their neighbours. Not only does the motion of the gas particles consist in a movement of translation from place to place, but each has also a vibratory motion of its own, and the constituent atoms composing the molecule have also probably relative motions. It is these vibrations of the molecule which, by communication of energy to the ether, and thence to our eyes, give rise to the luminosity of the gas. Now the different varieties of molecule have modes and frequencies of vibration of their own, which they tend to assume when shaken up and disturbed by collisions with their neighbours. The only time during which they can uninterruptedly vibrate in these characteristic modes is when they are on their "free path"—that is, on their course between two collisions. In gases this time is much longer than the time during which they are in collision, while in solids or liquids the time during which a molecule is free from contact with its neighbours is so small as to be inappreciable. The molecules are practically always so disturbed by jostling with their neighbours that they give out vibrations of all sorts, and thus the rays of light from strongly heated solids consist of all possible wave-lengths, and a continuous spectrum is formed.

## SCORPIONS AND THEIR ANTIQUITY.

By R. LYDEKKER, B.A.Cantab., F.R.S.

TO the circumstance that scorpions have their bodies protected by a coat of the hard substance technically known as chitine, the palæontologist is indebted for a knowledge of their past history and extreme antiquity; and it is owing to the preservation of their remains in the Palæozoic strata of both the old and new worlds that we are enabled to explain their present geographical distribution. There are many other groups of Invertebrates that we can have little doubt are fully as ancient as scorpions, but which lack a hard external investment, and whose past history is accordingly a blank. One of the most remarkable instances of this is afforded by the peculiar creatures termed *Peripatus*, repre-

XUM



THE GIANT SAND-SCORPION OF NAMAQUALAND, in two Attitudes, showing the Pincers, Legs, and Sting.

Slightly enlarged from Photographs by Dr. R. M. HOWARD, of Namaqualand.

sentatives of which are found in countries as remote from one another as South Africa, New Zealand, Australia, South and Central America, the West Indies, and Sumatra. These animals have much the appearance of caterpillars, having a pair of simple antennæ, and a large number of short, conical, caterpillar-like feet extending along the whole length of the under surface of the body, and each terminating in a pair of hooked claws. They breathe by tracheal tubes, after the manner of insects, but instead of these tubes opening by a regular series of apertures along each side of the body, their openings are scattered in an irregular manner over its whole surface. And it has been considered probable that these animals are closely related to the ancestral stock of insects, spiders and their allies, and myriopods. This being so, it is evident that *Peripatus* must be an extremely ancient type, and there is a great probability that if their remains were suitable for preservation we should find evidence of their existence in some of the oldest rocks of the northern hemisphere. It has, indeed, been assumed from their present geographical distribution that these, as well as many other types of animals, have always been southern forms, and that their presence in the great southern continents and islands indicates a former union of all the lands of the southern hemisphere. That there was a south equatorial belt of land in Palæozoic times seems to be pretty evident from certain peculiarities connected with the Carboniferous flowers of the northern and southern hemispheres, and it is, therefore, possible that in the case of *Peripatus* such an explanation may be the true one. Since, however, palæontology teaches us that many ancient types have migrated from their original northern home to find a refuge in the remote parts of the southern continents and islands, it seems more probable that such has also been the case with *Peripatus*. And if we can show that this has been the case with the scorpions, which now attain their maximum development in the more southern portions of the globe, the argument will be strengthened in the case of *Peripatus*.

Probably most of my readers are fairly well acquainted with the external appearance of scorpions, but, for those who are not, the publishers have reproduced two very beautiful photographs of a large African species, kindly sent me by Dr. R. M. Howard, of Namaqualand, and locally known as the sand-scorpion. Belonging to the great group of Arachnida, which includes the spiders, the scorpions are especially distinguished by their compressed bodies, and by the sharp separation of the cephalo-thorax from the abdomen, the latter consisting of seven segments, and being followed by six narrower segments, collectively forming the post-abdomen, the last of which is specially modified into the so-called sting. The cephalo-thorax or fore part of the body is covered by a shield-like carapace, upon the upper surface of which are carried a variable number of simple eyes, one pair of which is larger than the others, and is placed dorsally, while the smaller ones are marginal. The first pair of appendages are modified into short nipping claws, while the maxillary palpi are greatly enlarged to form the huge pair of pincers carried on each side of the head; and the four pairs of walking legs are supported by the first four segments of the thorax. It is important to add that by means of pulmonary sacks opening by four pairs of apertures on the sides of the abdomen, scorpions breathe air, and it is accordingly only in rocks of fresh-water origin, or such as were deposited near the shore that their remains are likely to be preserved.

According to the most recent classification, existing scorpions are divided into four families, of which the first two are again subdivided into several families. An important feature in this classification are the so-called "pedal spurs," which are found upon the articular membrane connecting the foot, a terminal segment of the legs, with the segment that precedes it. According to Mr. R. I. Pocock, the *Scorpionidæ*, or typical scorpions, have only one such spur, whereas two are present in the other three families. It will, however, be quite unnecessary to further consider the classification of the group in this place; but it is important to notice that one of the sub-families of the *Scorpionidæ* is confined to Africa south of the Sahara, and the Indian and Malayan countries; while another has representatives not only in those regions, but also in northern South America and Australia. At the present day, indeed, scorpions are found in Europe only in the more southern countries, where the majority of the species are of comparatively small size; and it is in the tropical and sub-tropical regions of the globe that the group attains its maximum development, the largest forms being, we believe, South American and South African. No scorpions are found in high northern latitudes, although they range as far south as Patagonia, and none are known from New Zealand. The species here figured belongs to the typical sub-family of the *Scorpionidæ*, which is confined to the Ethiopian and Oriental regions.*

According to the researches of Dr. Scudder, the modern scorpions agree with one another in that the median dorsal eye-tubercles are, as a rule, far removed from the front margin of the cephalo-thorax, and thus placed behind the lateral eyes. Apparently the only fossil scorpions agreeing with this group that have been hitherto discovered occur preserved in amber of late Tertiary age; scorpions being quite unknown in lower Tertiary or Secondary rocks. Needless to say that this is not owing to their non-existence in these epochs, but is due either to such rocks being unsuited to the preservation of their remains, or having been deposited far out to sea.

When, however, we reach the Palæozoic coal-measures, which are mainly of fresh-water origin, and, therefore, just where we should expect to find such creatures, remains of scorpions have been met with both in Europe and North America, some of the species attaining very considerable dimensions. Both in these Carboniferous scorpions, and also in certain still older ones from the Silurian rocks, the eye-tubercles are placed either on the actual front margin of the cephalo-thorax, or only a short distance behind it; and these forms are thus regarded as forming a group apart from the modern scorpions. In the Carboniferous genus *Cyclophthalmus*, the median eye-tubercles are immense, and occupy almost the entire front half of the cephalo-thorax; the lateral eyes forming a semicircle behind and to the sides of the larger ones. The maxillary palpi form pincers proportionally as large as in the modern forms, while the legs have similar double claws. The genus *Eoscorpius*, which is likewise common to the Carboniferous rocks of both halves of the northern hemisphere, has all the general features of the preceding, with the exception that the arrangement of the eyes is different; while *Proscorpius*, of the upper Silurian rocks of North America, is also of the same general type. With *Palæophonus* of the Silurian of Scotland and Gotland, we reach, however, a more primitive type, in which the walking-legs gradually taper to thin extremities, which terminate in simple claws or points, although the palpi still form large pincers.

Such is the palæontological history of scorpions; and a very remarkable history it is, seeing that most of the

* Mr. Pocock writes me that he believes the specimen to be *Opisthopthalmus pallipes*. The total length of the specimen in the original photograph, which is natural size, is just over five inches.

THE GIANT SAND-SCORPION OF NAMAQUALAND, in two Attitudes, showing the Pincers, Legs, and Sting. Middle enlarged from Photographs by R. M. HOWARD, of Namaqualand.

Palæozoic types are almost as highly specialized as their existing descendants, and thus showing that we should have to go much further back before we reached the ancestral type. With the exception of certain cockroach-like insects, which occur in the middle Silurian, the scorpions are indeed the oldest land animals, and are therefore entitled, in spite of their unpleasant propensities, to our utmost respect.

We have said that in Palæozoic times there existed a south equatorial land-girdle, distinguished from the land of the northern hemisphere (from which it was probably isolated) by the peculiar character of its fauna; and as the Palæozoic scorpions inhabited the northern land, it is scarcely likely that they were also found in the southern zone. Early in the Secondary epoch the latter zone appears to have been split up, and the continental areas consequently assumed some approach to their present configuration. The descendants of the ancient Palæozoic scorpions began soon after, in all probability, to migrate southwards, along the different lines of communication; and we thus can readily understand why some of the existing sub-families are represented in such widely separated areas as India, Africa, South America, and Australia, without resorting to any comparatively recent connection between these countries. In this connection it is important to notice that the South American and African scorpions belong to distinct genera.

If such an explanation holds good in the case of the scorpions, there is no reason why it should not be equally valid in the instance of *Peripatus*. It may be objected that, whereas in the case of the scorpions we have only *sub-families* which occur over such widely sundered areas, in *Peripatus* we have one and the same genus. The objection would, however, be equally valid if we assumed that genus to have attained its present geographical distribution by the aid of a southern band of land, seeing that there is no evidence that such a tract has existed since the end of the Palæozoic or the commencement of the Secondary epoch.*

Although not coming strictly within the scope of its title, this article may be concluded by a brief reference to some of the habits of scorpions. All scorpions are nocturnal and somewhat sluggish creatures; but while some species, in which the tail is light, carry it stretched nearly straight out behind, those in which it is heavier habitually curve it over the back; and those forms in which the appendage is carried in the latter manner are further distinguished by raising their bodies much higher on the legs than is the case with the others. Some kinds, again, when walking, carry their large pincers stuck out in front of the head to act as feelers. All scorpions are carnivorous, while many of them, in spite of their sluggish appearance, are able to capture and kill such alert creatures as cockroaches. Mr. Pocock, who has kept scorpions in captivity, writes that "as soon as a cockroach is seized, the use of the scorpion's tail is seen, for this organ is brought rapidly over the latter's back, and the point of the sting thrust into the insect. The poison instilled into the wound thus made, although not causing immediate death, has a paralyzing effect upon the muscles, and quickly deprives the insect of struggling powers, and consequently of all chance of escape. If the insect is a small one—one in fact that can be easily held in the pincers and eaten without trouble while alive—a scorpion does not always waste poison upon it. Thus I have seen a *Parabuthus* (one of the genera of scorpions) seize a bluebottle fly, transfer it straight to its mandibles, and pick it to pieces with them while still kicking. . . . . An insect is literally picked to pieces by the small chelate mandibles, these two jaws being thrust out and retracted alternately, first one and then the other being used; the soft juices and tissues thus exposed being drawn into the minute mouth by the sucking action of the stomach."

Old fables die hard, and none is more persistent than the legend that the scorpion, when surrounded by a ring of fire, puts an end to its existence by turning its tail over its back and stinging itself to death. No matter that naturalists have proved that their poison is innocuous to their own kind, and that scorpions are killed by a very moderate elevation of temperature, the old, old story is still as firmly believed as ever by the general public.

In an article published in the last edition of the *Encyclopædia Britannica*, the Rev. O. P. Cambridge refused to believe that there was any substratum of fact in the popular legend, but Mr. Pocock, writing in *Nature* for 1893, is more merciful. He thinks, indeed, that a scorpion may occasionally sting itself, either by a random blow meant for an unseen enemy, or when it has been irritated by the contact of any strong stimulant, such as acid or mustard, or even that in the madness of pain it may be driven to turn its weapon on itself; but that in any case there is any intention of causing its own death cannot for a moment be admitted.

Although, probably, many of my readers are acquainted with it, for the benefit of those who are not, I must conclude with a well-known Indian story. Where scorpions and centipedes abound, it is the general custom of servants in India to turn their master's boots upside down before helping to put them on. In the instance in question, where this precaution had been omitted, a cavalry officer had just put his foot into a regulation boot, when he felt something sharp touch his heel; with the greatest promptitude he lifted his leg and stamped violently on the ground in the hope of destroying the supposed scorpion before it had time to use its sting. He found that a spur, with the rowels uppermost, had been inadvertently dropped into the boot!

* It may be well to state that there are many fatal objections to the theory of an Antarctic continent which united South America, Africa, and Australia, having existed in Tertiary times.

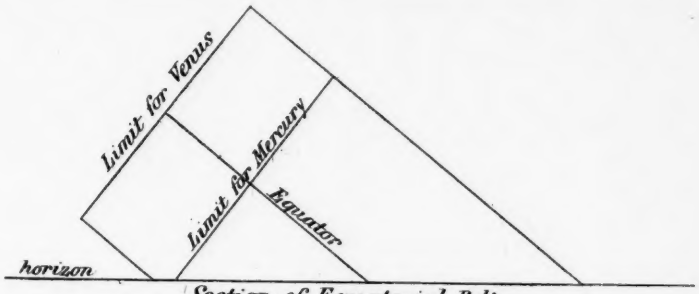
## SOME PLANETARY CONFIGURATIONS.

By Lieut.-Col. E. E. MARKWICK.

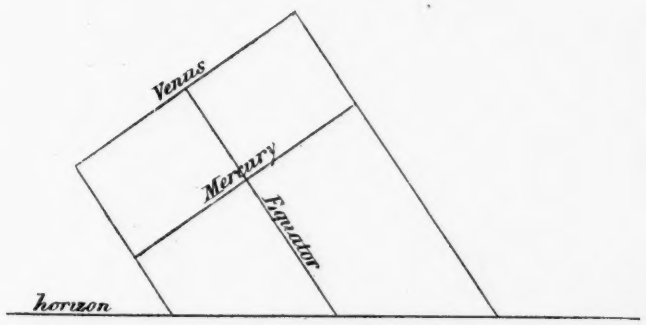
THE aspect of the planets in the sky at any given time has always been an interesting subject, and was one of the most important branches of the Old World astronomy. The Egyptians, Chaldæans, Babylonians, Greeks, and other ancient peoples studied the heavens by naked-eye observation, ages before the invention of the telescope, and the varying positions of the planets must have been well-known phenomena to them. Why, more than to us in England in the nineteenth century? They could see these things under much more favourable circumstances.

Firstly, because in their latitude—say about 36° N. as a mean—the equator, where it cuts the horizon, is tilted up at an angle of 54°, and hence, even supposing that the conditions of seeing were the same as ours, the planets—being confined within certain limits north or south of the equator—must be first seen in the evening at a higher altitude than in a latitude where that circle slopes at a less angle to the horizon. This is illustrated in our diagram, which shows a portion of the equatorial belt, 47° wide, within which Mercury and Venus are confined relatively to the sun. The orbits of Mercury and Venus being interior to that of the earth, and inclined to the ecliptic, they can

actually be seen sometimes a few degrees outside this belt. This extra wandering beyond the tropics of Cancer and Capricorn has not been taken into account in the figure.




*Section of Equatorial Belt looking due W. at Sunset Lat 52° N*

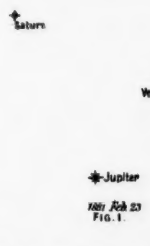



*The same Lat. 36° N.*
*1 in = 30°*

Secondly, the people of Chaldæa and Southern Europe have an infinitely better climate than we have. Their sky is more free from clouds and haze, and the transparency of the air is greater, often allowing bright celestial objects to be seen down to the horizon. Sir R. F. Burton speaks of the "glorious desert" with its "translucent skies that show the red stars burning upon the very edge and verge of the horizon."

Thirdly, in Eastern cities, especially in ancient days, the buildings were probably not, as a rule, very high, and the flat roofs were conducive to studying the heavens without inconvenience.

Moreover, as a general rule, fires would be little needed, and this alone tends to preserve the clearness of the air. The circumstances of the East, therefore, are highly favourable to naked-eye observation, and even invite it.




Those who have sojourned in low latitudes—not necessarily within the tropics, but from 30° to 40° either N. or S. latitude—will no doubt remember how favourably the heavenly bodies are seen, especially after sunset and before sunrise, owing to the shortness of the twilight. I have frequently observed in S. latitude 25° to 34°, with a feeling akin to awe, some three or four lustrous orbs blazing in the evening sky, and they look, perhaps, still more mysterious when seen in the early dawn. One needs to have been bivouacing, rolled up in a blanket, to appreciate an early morning sky. Then no window glass impedes the view, and as soon as one is awake the bright stars are seen, and if there are any planets visible, they cannot fail to be observed. Those who have travelled on the upland rolling plains of South Africa (without tents) will probably recall such sights, albeit they are not addicted to a study of Urania and her charms.

The planet Mercury is generally considered a difficult object in our latitude for naked-eye observation, although with a little care at favourable elongations, and with a clear sky, there is no difficulty in seeing him.

In lower latitudes Mercury becomes a brilliant object, and a very important factor in all planetary collections where he is present. On the evening of February 26th, 1894, at Gibraltar, Mercury was seen after sunset as a brilliant star in the western sky, when no other celestial body was visible in the neighbourhood. It seems to be generally inferred in the text-books on astronomy that it was somewhat remarkable that the ancients were acquainted with Mercury; but to anyone who has seen that planet in the latitude of Greece, it would seem a most remarkable thing if the planet had not been seen and noted as such.

To illustrate this, two diagrams have been prepared representing a configuration of Antares, Venus and Mercury witnessed in South Africa. The first represents the planets and star (as they were seen in S. latitude, 26°) on the 30th October, 1880, and the second the position three days afterwards. Independently of the fact that both Venus and Mercury were much brighter than the star, the motion and change of position of the planets in three days is quite enough to show to the most casual observer that we have to deal here with wanderers among the stars.

Perhaps the following, extracted from an astronomical diary relating to this, may be of interest:—

"1880, October 19th.—A cloudless sky, with dry air without a particle of dew. The distance between Venus and Mercury is not much altered. The air was so clear down to the horizon that I saw Mercury and Venus, and one or two stars set quite sharply, with a sudden disappearance quite unlike anything seen in England.

"October 30th.—Mercury and Venus very finely situated in Scorpio, the contrast of the two white planets with the ruddy Antares being pretty.

"November 2nd.—A very fine triangle formed by Antares, Venus and Mercury, Venus blazing white, ten times magnitude of the others; Mercury next in brightness, a little ruddy, and Antares smallest, although a most lovely flashing red.

"November 7th.—Much interested in watching the various changes of position of Antares, Mercury and Venus.

To-night the first two are, comparatively speaking, close together and Venus a long way off."

In Figs. 1 and 2 are shown configurations of Venus, Jupiter, and Saturn seen on the evenings of February 23rd and March 2nd, 1881, adjusted for N. latitude 36°. This configuration was very noticeable on account of the brightness of the planets.

In 1885 a fine conjunction was witnessed in Bechuanaland, viz., Mercury, Venus, Jupiter, and Regulus. The scale is too large to bring in Jupiter, but Fig. 3 shows the other three objects visible on July 16th.

Fig. 4 shows the same three planets and star (for the same latitude) as visible on July 31st, 1826, the positions being laid down from data in the *Nautical Almanac* for that year.

1882, September 20th, there was a pretty combination of Spica, Mercury, and Mars. The first two were in the field of the telescope (a $2\frac{3}{4}$ inch refractor) and presented a beautiful contrast: Spica being a steely blue and Mercury a rich orange-red colour. Mercury by far the brighter, both in the telescope and as seen with naked eye. Mars a deeper red than Mercury.

1882, October 16th. Venus and Antares were visible together in the telescope. Fine contrast between the ruddy hue of the star and the whiteness of the planet.

Many English readers will probably remember the conjunction of November 3rd, 1877, when Mars and Saturn were in the same field; also that interesting spectacle of Jupiter and Venus seen so close together in February, 1892.

Suppose the five principal planets, Mercury, Venus, Mars, Jupiter, and Saturn, arranged in a straight line, each being 1° (say) from its neighbour. These can be arranged in one hundred and twenty different ways. Now vary the distance in R.A. and introduce the element of declination, *i.e.*, extend the line into a belt 47° wide, and we increase enormously the possible combinations. Throw in one fixed star, such as Antares or Regulus, and leave out one or two planets, and it is evident that we only require sufficient time to get myriads of configurations—no two of which would ever be exactly alike. Of course, the conjunction or near approach of five principal planets, as seen from the earth, is a rare event in the history of the solar system.

30th October 1880
FIG. 5

This subject is not usually much dwelt on in text-books, but Chambers gives some interesting examples, from which the following are taken.

From the Chinese records it is stated that Mars, Jupiter, Saturn, and Mercury were in conjunction, in the constellation Shi, for which the dates February 28th, 2446 B.C., and February 9th, 2441 B.C. have been assigned by two authorities.

On September 15th, 1186, Mercury, Venus, Mars, Jupiter, and Saturn were in conjunction between the wheat ear of Virgo and Libra. This must have been a wonderful sight, if it occurred at a sufficient distance from the sun to enable all these planets to have been seen at once. It would apparently have been an evening configuration, and any historical references to this, if they exist, would be very interesting.

2nd November 1880
FIG. 6

On November 11th, 1524, Venus, Jupiter, Mars, and Saturn were very close to each other, and Mercury only 16° distant.

Exactly twenty years later, on November 11th, 1544, Venus, Jupiter, Mercury, and Saturn were included in a space of 10°.

On March 17th, 1725, Venus, Jupiter, Mars, and Mercury were in the same field of the telescope—a truly remarkable assemblage.

It will be seen that I have touched but lightly on a wide subject. For the mathematician and computer there is a great field in accurately calculating all the interesting conjunctions of historical times. Then there must be many references in histories and chronicles to the subject, the hunting up of which would give work to the literary student.

For myself, I am content in simply pointing out the interest of the subject to anyone who is fond of surveying the evening or early morning sky, with the only instrument Nature has given him, his eyes. If such an one has the means or the good fortune to get to latitude 36°, or nearer the equator still, he will then enjoy, with a zest increased by comparison with his poor English views, the splendid sights of planetary groupings he is sure to be favoured with.

## THE DIAMETER OF THE FIELD OF VIEW OF A TELESCOPE.

By THOMAS H. BLAKESLEY.

IN the last edition of Mr. Webb's most excellent book, "Celestial Objects for Common Telescopes," and presumably in earlier editions of the work, the author, admitting the usefulness of the knowledge of the diameter of the field of view of a telescope, gives, as a rule for finding this value, to time the passage of an equatorial star centrally across the field, and multiply the time so occupied in minutes and seconds by fifteen to obtain the angular value in minutes and seconds of arc.

The author of the book recommends several trials of this sort, and the mean value of the angles so obtained is to be taken as the truest. Now, in the first place, it is obvious that the *mean* of such trials is not the best value, but apart from this consideration, it is by no means an easy matter to arrange a common telescope so that a star shall pass through the centre of an open field, and even if the star has so passed there is no proof of the fact in anything of the nature of contact or intersection. The method, indeed, is eminently of a theoretical character for any but a well-divided field. In Godfray's "Treatise on Astronomy" directions of the same general character are given for finding the diameter of a Ring-micrometer.

The method suggested in this paper is free from the objections indicated above, especially in the important fact that the results may properly be meaned. The observed times involved begin and end with definite contacts, and central passage is not needed. The sun is the heavenly body employed, so that the observations may be made on

any fine day, and repeated as often as desired. Moreover, the declination of the sun is unimportant.

The principle involved is that if two circles move with a uniform relative velocity, $v$, so as to make both external and internal contacts, and if $t_1$ is the interval of time between external contacts, and $t_2$ the interval between internal contacts, the product of the two radii $R\,r$ is equal to the very simple expression $\frac{v^2\,(t_1{}^2-t_2{}^2)}{16}$.

If now the two circles are the sun and the field of view of a telescope at rest, the radius of the sun is given in the *Nautical Almanac*, and the value of $v$ may be computed by dividing the radius of the sun by the time ($t_0$), also given in the *Nautical Almanac*, which the radius of the sun occupies in passing the meridian. In fact, if $r$ refers to the sun $v=\frac{r}{t_0}$, and we have for the radius of the telescope's field, $R=\frac{r}{16}\,\frac{t_1{}^2-t_2{}^2}{t_0{}^2}$.

In practising this method there would be some uncertainty about the time of the first external contact, as the sun, being out of sight the instant before, cannot be watched up to contact in this case. From the symmetry of the motion, however, this first point can be computed from the fact that it must occur as much before the first internal contact as the second internal contact occurs before the last external contact.

It is, indeed, very convenient not to take the first contact into consideration at all, for much the easiest way to ensure the motion giving the internal contacts is to get the sun into the field, and then to displace the telescope slightly in the direction of the sun's motion. Things will then be in a position to give the first internal contact in a few seconds, and the two other contacts wanted must follow as a matter of course. Modified in this way the equation for the diameter of the field, D, becomes :—

$$D=\frac{r}{2}\,\frac{t_3\,t_4}{t_0{}^2}$$

When $t_3$ is the interval of time between the first internal contact and the last (now the only) external contact,

and $t_4$ is the interval of time between the second internal contact and the external contact,

$t_0$ (given in the *Nautical Almanac*) is the time of the sun's radius crossing a meridian.

$r$ (given in the *Nautical Almanac*) is the radius of the sun.

If $t_3\,t_4$ are given in the same denomination as $t_0$, well and good; but $t_0$ is given in the *Nautical Almanac* in sidereal interval, and it will very often happen, at least with amateurs, that $t_3$ and $t_4$ are measured in solar interval. If so, the result must be increased by 5·5 per thousand.

The fact that the motion of the sun is not entirely at right angles to the meridian, would not, under the most favourable conditions for doing so, produce a greater error than one part in 600,000, and its further consideration may therefore be neglected. On the other hand, for those who are content with less rigid approximations to truth, the equation may be simplified by taking average values of $r$ and $t_0$, in which case we have, dispensing with the *Nautical Almanac*—

$$D\text{ (in minutes of arc)}=\frac{t_3\,t_4}{558}$$

where $t_3\,t_4$ are taken in seconds.

It need scarcely be pointed out that Ring-micrometers can be measured in the same way.

## NOTICE.

THE publishers of KNOWLEDGE have the pleasure to announce that Dr. Isaac Roberts, F.R.S., has kindly offered to continue in KNOWLEDGE his exquisite selection of Photographs of Stars, Star-Clusters, and Nebulæ, and the first photograph will appear very shortly. The series is intended to be in continuation of Dr. Roberts' recently published work, "A Selection of Photographs of Stars, Star-Clusters, and Nebulæ," which has contributed largely to the extension of the knowledge of astronomical phenomena.

## DR. ROBERTS' PHOTOGRAPHS OF STAR-CLUSTERS AND NEBULÆ.

By E. WALTER MAUNDER, F.R.A.S.

DR. ROBERTS has won for himself so high and well-deserved a reputation by his photographic studies of star-clusters and nebulæ, that I am assured the above announcement will give the greatest gratification to every reader of KNOWLEDGE. More, it will carry out in the completest way the programme which the late Editor, Mr. Ranyard, especially proposed to himself. Realizing how marvellous and powerful a weapon of astronomical research photography had become, and the yet wider influence which it promised to have in the future, Mr. Ranyard desired to place the very best results of astronomical photography in the hands of his readers, and the last four or five volumes of KNOWLEDGE are a sufficient monument to his energy and success.

There can be no doubt that in so doing he inaugurated a new epoch in observational astronomy. Hitherto the great hindrance to the extension of astronomical observation has been its cost, and the heavy demands which it makes upon the time of those who take it up. To purchase and set up a telescope of sufficient power to deal with any object except, say, Jupiter and the Sun and Moon, is beyond the reach of all but a very few; to have the strength and leisure to devote night after night to using the telescope is a rarer good fortune still. Hence the amateurs who adopt the microscope for their hobby outnumber those who adopt the telescope by ten times over and more.

The rise of astronomical photography has altered all this. We have now many large observatories devoting much of their equipment to taking photographs—photographs for the complete discussion of which they possess no adequate staff. In so doing they have, as it were, brought down this or that portion of the heavens within our reach to handle as we like. The photograph once taken is for many purposes as good as—for some purposes even better than—the original object itself.

Here, then, is a fruitful field for those who have neither the means to erect a large telescope, nor the leisure to use it. The examination, the measurement, and the reduction of astronomical photographs may well be taken up as a most useful and interesting work by many lovers of astronomy, who would otherwise find themselves debarred from any active share in the advancement of the science. We may put the matter more strongly. It not only may be so taken up; it *ought* to be, and no doubt before very long we shall see this new order of astronomical workers begin to be formed.

We may indeed say that a commencement has already

been made. The labours of Dr. Weinek, referred to in the June number of KNOWLEDGE, may be cited as a case in point. The original photographs have been taken at the Lick Observatory, or by MM. Loewy and Puiseux at the Paris Observatory,* and Dr. Weinek has reproduced them on a greatly enlarged scale, which has brought into prominence many new and minute details. Again, at the Cape Observatory, a work of the first order of importance has been carried out—a complete photographic survey has been made of the southern heavens. The measurement and reduction of this valuable series of plates was impossible at the Cape Observatory itself, owing to the smallness of the staff and the total insufficiency of the funds placed by the Government at the disposal of the Director. But what the parsimony of the British Government failed to do has been accomplished by the devotion of a foreign astronomer, and the plates of the Cape *Durchmusterung* have been measured and reduced by Prof. Kapteyn.

This work is one not of merely national, but of international importance, and it is not to be expected that similar tasks can often be undertaken, or that any amateurs could in the general way take part in them. An example of a useful piece of work within the power of many amateurs may be seen in the reduction, by Mr. A. Stanley Williams, of a series of photographs of Jupiter taken and measured at the Lick Observatory, and communicated by him to the Royal Astronomical Society (*Monthly Notices*, Vol. LI., p. 402).

But that amateurs may undertake work of this description, it is first of all necessary that they be supplied with the photographs. This was the first object Mr. Ranyard had in view in the reproduction of so many photographs in KNOWLEDGE. This, too, was Dr. Roberts' chief purpose in the publication of his volume of "Photographs of Stars, Star-Clusters, and Nebulæ." These photographs have been carefully reproduced in a form to render them available for measurement and reduction. The scale value is given for each plate, and four or five fiducial stars are indicated on each, and their places for the epoch 1900 given, so that the positions of other stars may be readily ascertained.

These particulars will be carefully given by Dr. Roberts for the photographs which he proposes to publish in KNOWLEDGE. They will not, therefore, be *merely* beautiful pictures—that they will be such those who know Dr. Roberts' published volume will feel assured—they will be available for strictly scientific treatment, and it is to be trusted that they will not fail to receive it.

The first use to which these photographs may be expected to be put is to determine the relationship between stellar distribution and nebular structure. For this purpose the published paper reproductions will not be greatly inferior to the original negatives, and it is to be hoped that there are not a few careful observers who will subject them to the most detailed scrutiny. What would Michell, what would the Herschels, what would Proctor, have given to have such records placed in their hands?—records which, in Dr. Roberts' own words, "portray portions of the starry heavens in a form at all times available for study, and identically as they appear to an observer aided by a powerful telescope and clear sky for observing."

* By a careless slip, the photograph from which the enlargements reproduced in the June number of KNOWLEDGE were made by Dr. Weinek was said to have been taken by the Brothers Henry (p. 135, col. 1, line 34). The instrument with which the photograph was obtained—the Equatorial Coudé—was indeed due to their skill, but the actual photograph was taken by MM. Loewy and Puiseux.

## THE GREAT NUBECULA.

By E. WALTER MAUNDER, F.R.A.S.

THE readers of KNOWLEDGE are indebted, as on so many previous occasions, to the skill and success of the Director of the Sydney Observatory, Mr. H. C. Russell, for the photographs which are reproduced in the present number. Like the pair of photographs which we published in April, these were taken with the Sydney "Star Camera," *i.e.*, with the telescope constructed for the International Astrographic Survey, and of the standard aperture and focal length. They represent two contiguous fields in the very heart of the Greater Magellanic Cloud, the northern edge of Plate I. corresponding to the southern edge of Plate II., and they should be compared with the fine photograph of the same region taken by Mr. Russell with a six-inch portrait lens on October 17th, 1890, and published in KNOWLEDGE for March, 1891. The earlier photograph received an exposure of 7h. 3m., and is remarkable for the vast masses of nebulosity which it revealed; nebulosity the spiral character of which was distinctly shown upon the original plate, constituting it, as Mr. Russell remarked, "the grandest spiral structure in the heavens." The present pair of photographs are much less impressive regarded merely as pictures, for they bring out much less extended nebulosity. This is the necessary consequence of the shorter exposures given to them—the exposure for No. I. being $4\frac{1}{2}$ hours and for No. II. $5\frac{1}{4}$ hours—and of the greater proportional focal length of the star camera as compared with the portrait lens. On the other hand, the numbers of the stars shown are far greater on the present plates than on that taken in October, 1890, and the scale is larger, so that minuter details are seen. The earlier photograph was taken on a scale of 0·556 inches to the degree; the accompanying plates are on a scale six times as great, being enlarged from the originals, which gave a scale of 2·36 inches to the degree.

There is, perhaps, no object in the heavens which has been of such importance in the development of our views as to cosmical structure as the Great Nubecula. For this vast object, extending, according to Sir John Herschel, over forty-two square degrees, is not only the very hive and home of nebulæ—the region of the entire heavens where they crowd most closely—but it is full of groups and streams of undoubted stars. This one object, therefore, was itself sufficient to disprove the old idea that nebulæ were but extremely distant galaxies, nebulous only by their untold distance; for it is plain that the depth of the Nubecula can be only a fraction of its distance from us. However vast, therefore, its real dimensions, we may regard all its members as practically at the same distance from us; we cannot suppose that its furthest extensions are double as far or even one-quarter as far again as its nearest. It is not due, therefore, to differences of distance that it appears to consist, according to Sir John Herschel's well-known description, "partly of large tracts and ill-defined patches of irresolvable nebula, and of nebulosity in every stage of resolution, up to perfectly resolved stars like the Milky Way, as also of regular and irregular nebulæ properly so called, of globular clusters in every stage of resolvability, and of clustering groups sufficiently insulated and condensed to come under the designation of clusters of stars." The differences in appearance are due to real differences of aggregation and of condition, and are not simply due to the disguising effects of distance. This lesson, that nebulæ were not "external galaxies" irresolvable by effect of distance, was the first lesson taught by the Great Nubecula. Its second lesson, that nebulæ equally with

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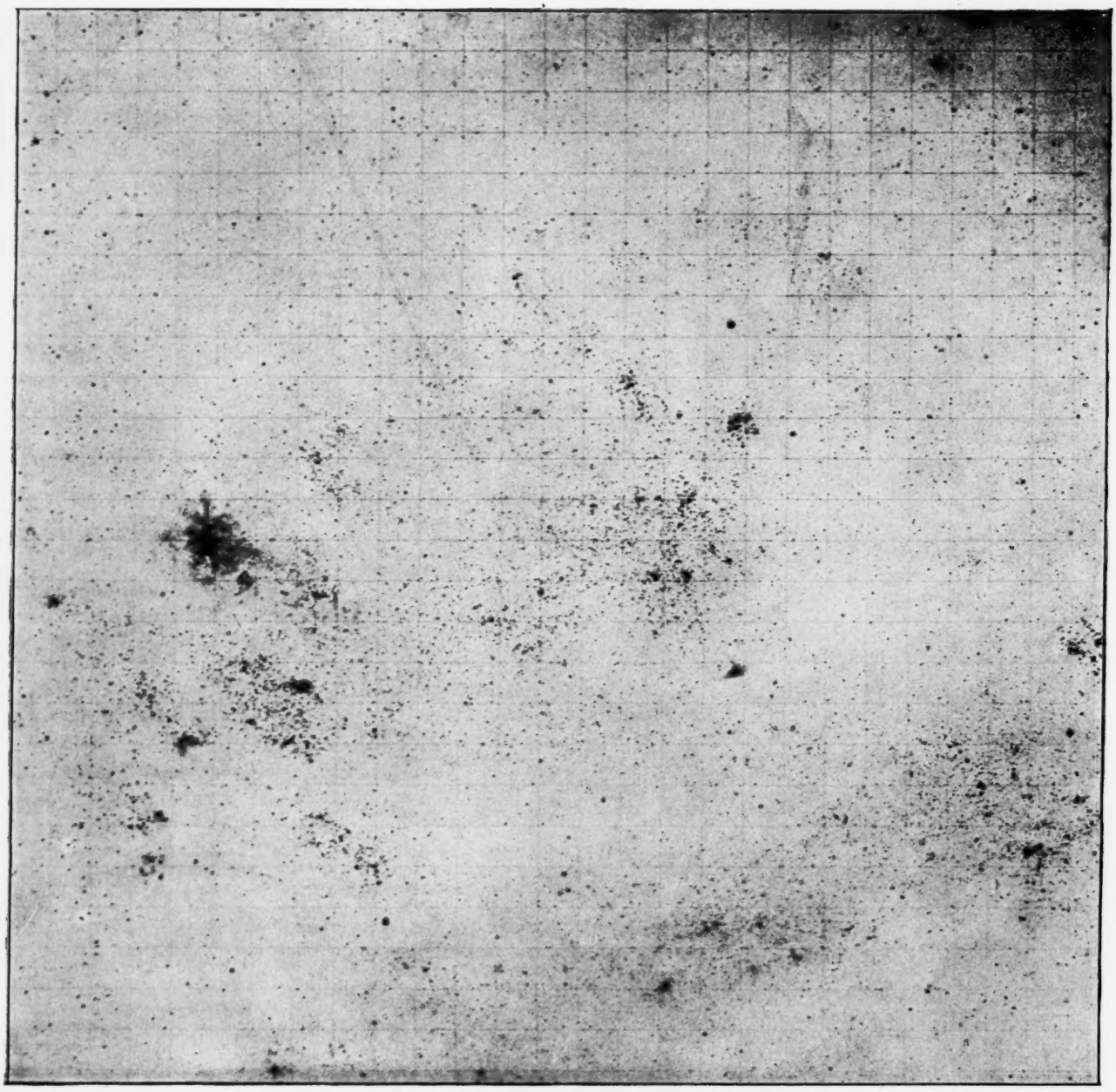
NORTH.



FOLLOWING.

PRECEDING.

**I.—PHOTOGRAPH OF PART OF THE GREAT NUBECULA.**

Taken by Mr. H. C. Russell, with the Star Camera of the Sydney Observatory, December 9th, 1893. Centre of Plate, R.A. 5h 31m. 48s.; S. Dec., 69° 8′ 0″. Exposure, four and a half hours.

NORTH.

FOLLOWING.

PRECEDING.

PRECEDING.

**II.—PHOTOGRAPH OF PART OF THE GREAT NUBECULA.**

Taken by Mr. H. C. Russell, with the Star Camera of the Sydney Observatory, December 3rd, 1894. Centre of Plate, R.A. 5h. 33m. 18s.; S. Dec., 66° 47′ 0″. Exposure, five and a quarter hours.

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stars are component parts of our sidereal system, and that this forms but one single structure, is one taught on a larger and more impressive scale by the manner in which the unresolved nebulæ shrink from the galactic zone. But the great interest of the Nubecula lies in the different manner in which that lesson is taught. In the heavens at large the condensations of stars and of nebulæ (other than planetary) tend to avoid each other, and by that very avoidance prove that they are but different parts of a single evolution. Here we have such condensations intermingled in a single formation, as if that mysterious repulsion between stars and nebulæ which had caused the nebulæ to cluster round the very pole of the Milky Way, as in the "rich" region of Virgo, had not attained here an equal development. Here we have still preserved to us a fragment of the cosmic embryo, or at least a region wherein the forces which elsewhere have effected so marked a stratification have not yet worked out a like result.

This region, which, as it were, combines together a fragment of the Milky Way with a rich gathering of the objects most foreign to it, contains also one fine example of the irregular nebulæ, the only member of the class found outside the galactic zone. This is 30 Doradûs, the "great looped nebula," one of the most remarkable objects in the entire sky; a piece of complicated lace-work, executed in misty light. The nebula is on the central line of Plate I. and near the following side.

For further lessons from the Nubecula we must look to the photographic plate. Already Mr. Russell has shown us in his photograph of October 17th, 1890, the spiral nebulosities which link together its complexity of structure. The present plates bring into prominence rather the great differences of condensation which mark different regions in it. Both testify to the importance of studying it with every variety of photographic telescope available, and with great range of exposure. The photographic analysis of an object like this, which seems to be a sort of epitome of the entire sidereal heavens, cannot fail to be of the utmost service in extending our knowledge of stellar evolution.

## Science Notes.

Prof. E. Hull, LL.D., F.R.S., in a paper just read before the Victoria Institute, has brought forward some further remarks—in addition to those he recently brought before the Geological Society, on the physical conditions of the Mediterranean basin, which have given rise to a community of some species of the freshwater fishes in the Nile and the Jordan basins. The author traced the various changes which the Mediterranean basin had undergone since the beginning of the Tertiary period, resulting in the formation of a chain of freshwater lakes (as previously suggested by Dr. Leith-Adams and Admiral Spratt), when elephants and hippopotami inhabited the lands surrounding Sicily and Malta. The author considered that the formation of these freshwater lakes was brought about by the greater extension of the land areas and decreased evaporation, which caused the waters of the Mediterranean lakes to flow outwards into the Atlantic. These conditions would be brought about by a general uprise of 250 fathoms taking place in the later Pliocene period. The freshwater conditions would admit of intercommunication between the fauna of the North African rivers and those of Asia Minor, while the connection with the Jordanic basin—in which the waters stood 1300 feet (or more) above the present level of the Dead Sea—would have been established by one or more streams draining into the eastern basin by the depression of the Plain of Esdraelon.

Geologists have for many years been waiting for further evidence with regard to the great question of the antiquity of man. Although evolutionists believe that man probably originated in the Miocene period, yet at present there is no definite evidence for so great an antiquity as that. The Abbé Beourgois believes that he has found flint implements at Thenay, in France, in a Miocene deposit, but the evidence is not satisfactory. Last year Dr. Fritz Noetling reported a discovery of flint-chips, believed to be the work of man, in certain strata in Burmah, which by some authorities were believed to be of Miocene age; but these are now proved by their fossil contents to be of Pliocene age. Dr. Prestwich has recently described some very rude flint implements from the plateaux gravels near Sevenoaks, which he considers to be preglacial, and, therefore, possibly of Pliocene age. (*The Nineteenth Century*, April.)

Mr. Worthington Smith states that human bones have been more than once discovered in Palæolithic gravels, but were lost or broken through carelessness. Some remarkable finds have recently been made in the Loess deposits of Moravia. Ten nearly complete skeletons were found in the natural positions as they had been buried in the brick-earth, and mammoth bones were associated with them. Probably they represent a family; and a block of stone had been placed on the tomb to prevent the ravages of wild beasts. The skulls are dolicocephalic (or long-headed) with retreating forehead, and strong ridges over the eyes. A few weeks ago a very animated discussion took place at the Geological Society over a human skull and limb-bones found in the Palæolithic gravel of Galley Hill, Greenhithe, Kent, ninety feet above the Thames, which were carefully described in a paper by Mr. E. T. Newton. Those who found these remains were convinced that they represented a Palæolithic man; but Sir John Evans and Prof. Boyd Dawkins preferred to think that this was an interment of Neolithic age, although to many present the evidence seemed to be the other way.

A very important event in the scientific world is the recent publication of the last of the volumes of "Reports of the Voyage of H.M.S. *Challenger*," in two parts, giving a summary of the scientific results. It is not too much to say that this was one of the grandest and most successful of scientific expeditions that has ever been organized.

The programme of arrangements for the meeting of the British Association at Ipswich has been issued. The first general meeting will be held on Wednesday, September 11th, when Sir Douglas Galton will assume the presidency and deliver an address. On Thursday evening, September 12th, a *soirée* will be held. On the following evening a discourse will be delivered by Prof. Silvanus P. Thompson on magnetism in rotation. On Monday evening, September 16th, there will be a discourse by Prof. Percy F. Frankland on the work of Pasteur, and its various developments. A second *soirée* will take place on Tuesday evening, September 17th, and the concluding general meeting will be held on Wednesday, September 18th.

The following candidates have been selected by the Council of the Royal Society for election as Fellows:—Mr. J. Wolfe Barry, Prof. A. G. Bourne, Mr. G. H. Bryan, Mr. J. Eliot, Prof. J. R. Green, Mr. E. H. Griffiths, Mr. C. T. Haycock, Prof. S. J. Hickson, Major H. C. L. Holden, Mr. F. C. McLean, Prof. W. MacEwen, Dr. S. Martin, Prof. G. M. Minchin, Mr. W. H. Power, Prof. T. Purdie. The absence of representatives of geological science from this list is noteworthy.

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Dr. Keeler's famous observations on Saturn's rings have begun to pass through the furnace of criticism. After being generally accepted by laymen, they are not quite so universally held to be conclusive by astronomers. M. Deslandres, for instance, does not consider the kind of evidence adduced by Dr. Keeler as any proof of the meteoric nature of the rings, a theory which Clark Maxwell first brought forward and the recent spectroscopic observations were supposed to confirm.

## Letters.

[The Editor does not hold himself responsible for the opinions or statements of correspondents.]

### SUNSPOTS.

*To the Editor of* KNOWLEDGE.

SIR,—In KNOWLEDGE for May, at pages 98, 107-110, the magnetic perturbations of March 30th-31st, 1894, are referred to the group of sunspots approaching the central meridian on those days; whereas these perturbations were due to the disturbance at the sun's eastern limb at the same time. The sun was likewise distinguished by the presence of spots south of the solar equator, which is the precise location most likely to be attended by auroral and magnetic effects near the vernal equinox. No matter what spots appear elsewhere on the sun, whether great or small, or east or west of the central meridian, whenever an aurora appears a region specially frequented by spots will be found at the eastern limb. In the case of the magnetic storms and fine auroras of March 30th-31st, 1894, there were recurrences at the 27¼ day interval, both of the solar conditions and of the attendant magnetic phenomena and of thunderstorms, which followed precisely the order which I have pointed out in various notes and articles, and which is referred to in the recently published volume of the International Scientific Series on the Aurora, by M. Angot.

M. A. VEEDER.

New York, U.S.A., May 14th, 1895.

### MIRA—PRISMATIC COLOURS ON CLOUDS—MIRAGE.

*To the Editor of* KNOWLEDGE.

DEAR SIR,—If you can spare me space, I should like to remark on the various observations made by your correspondents. I can quite endorse Col. Markwick's observations of Mira; the light curve was quite unusual. At the beginning of February it reached what should have been its maximum of about 4th magnitude, or rather less, and by the end of the month seemed inclined to fade; but during March it rose very suddenly again to about 3·5 magnitude (between $\gamma$ and $\delta$ Ceti), as nearly as one could judge in the twilight, on the 10th, and then fell quickly again.

I am also following R Leonis, but do not think anything abnormal occurred. The maximum must have been during the time of bright moonlight in March, for the star was seen with the naked eye, with the full moon in the same constellation just before the total eclipse, and it must have been 5th magnitude at the least.

With regard to the prismatic coronæ and edges to clouds, I may say that I have recorded them for some years, and see them on the pearly white cloud streaks on which they principally occur about twenty-five times in a year. I look upon them as one of the most certain signs of showery weather which we have, but halos are commonest in dry, sunny seasons. Mock suns are commonest in the spring, and are seen here about twelve times a year.

One does not have to go to the Sahara to see a very fair presentation of the mirage. They are common on dry, sandy shores when the sun is hot, especially with an easterly wind. A fortnight ago I saw a very good one on Stert Flats, a wide expanse of sand in Bridgwater Bay. On sitting down the sands seemed partly covered with water, in which the opposite village of Burnham was reflected, and I distinctly noticed that where red houses occurred in the 'sea-front' the colour was plainly imaged in the mirage. So was a small white lighthouse standing on the sands; but the taller one standing back among the sandhills did not appear. On standing up again, the whole phenomenon disappeared.

Bridgwater. H. CORDER.

### THE SUN PILLAR.

*To the Editor of* KNOWLEDGE.

DEAR SIR,—In your June number the Rev. S. Barber figures and describes a sun pillar seen in Cumberland on the 30th January last. On the 10th May a similar column was visible here for about a quarter of an hour, beginning at three minutes before 8 p.m. It had a delicate rose tint, and a small bright shooting star seemed to spring from its left side, and made a short trajectory. I suppose this was an accidental coincidence. The column, I am told, was seen at Eastbourne, but I have heard no particulars. On the 12th May a fine solar halo appeared at 12.45, and was visible for half an hour.

Forest Row, Sussex. HENRY J. SLACK.

*To the Editor of* KNOWLEDGE.

SIR,—Mr. Barber's account of the sun pillar in your June number is most interesting, as it reminds me of a similar phenomenon observed here by my father in 1868, to which he called my attention at the time, and which exactly agreed with your illustration. I find his notes were as follows:—

"April 16th. Sun column continuing half an hour after sunset, which was perfectly bright without clouds."

It occurred during a dry cold period, although a little rain had been measured early that day. Wind N.—and was succeeded by a wet period after the 18th.

Yours truly,

Further Barton, Cirencester. (Miss) E. BROWN.

### THE COLOURS OF BUTTERFLIES.

*To the Editor of* KNOWLEDGE.

SIR,—In your last issue Dr. Marshall has summarized, and apparently adopted, the views of Mr. A. R. Wallace, in regard to "the colouring of butterflies"; these views being in support of the Darwinian doctrine of natural selection. Dr. Marshall classifies his remarks under the following heads, viz.:—

*Protective colours.*—Referring to butterflies which are protected by imitating the forms and colours of any object on which they perch.

*Warning colours.*—In which the colours of the butterflies "are conspicuous for the purpose of *warning* other insects (Wallace says enemies) to keep away."

*Mimicry.*—"Many butterflies escape destruction by mimicking the colours and the markings of the uneatable forms."

In all these cases it will be seen that it is inferred that, while some butterflies are protected by their colouring, there are others which are not so protected; indeed, Mr. Wallace expresses his wonder that, "with these great resources at her command, Nature had not produced more of these mimicking forms than she has done."

It will also be seen, from Dr. Marshall's paper, that the inferences drawn from the facts which he relates are, that those butterflies which are thus protected *survive*, while those that are unprotected perish, or, at least, are liable to destruction; and the question naturally suggests itself—Why do any butterflies remain unprotected? Why has Nature, by means of her handmaid—natural selection—not afforded them the same protection as the others? and further—If some have remained unprotected for "thousands of generations," as Mr. Darwin would say, how have they escaped destruction so long? how have they come also to survive, if protection is necessary, as Dr. Marshall seems to say, for the preservation of their life?

Another inference, I think, is plainly deducible from what is said, especially under the head *mimicry*, viz., that the edible butterflies, seeking protection by mimicking the warning colours of their inedible neighbours, evince an amount of intelligence and knowledge of the effects of different colours which we are hardly prepared to expect from such low organisms as butterflies and caterpillars. True, Mr. Wallace refuses to allow that the mimicry is a voluntary act on the part of the insects, but he constantly speaks as if it were, and the words "mimicks" and "mimicry" necessarily imply, as every school-boy knows, an active agent, as, indeed, so do the words "natural selection," as the Duke of Argyll and others have clearly shown.

Is there any well-authenticated case in Nature to support such a view? I have heard or read of none—the chameleon is not a case in point.

Remark also that insects, which use warning colours, are so considerate as to protect, not themselves only, but even their enemies from injury.

Again, I ask, if certain insects have been able to protect themselves in this way, why do not all their neighbours follow their clever example? When I say "protect themselves," I only use a phrase which Mr. Wallace himself uses, for at page 190 he says "domesticated animals are protected by man—wild animals have to *protect themselves*."

Altogether, I am constrained to look upon the theory involved in Dr. Marshall's article as an entire misunderstanding of the interesting facts which he relates, and to ask—what has all this to do with the *Origin* of Species?

Broughty Ferry. WM. MILLER.

## Notices of Books.

*British Mammalia*. By R. Lydekker, B.A., F.R.S. Pp. 339. 6s. *Carnivora*. By the same author. Pp. 312. 6s. (W. H. Allen & Co., Limited.) These are two new volumes in the "Naturalist's Library," edited by Dr. Bowdler Sharpe. The former is practically a revised and enlarged edition of Macgillivray's work published in "Jardine's Naturalist's Library." With Mr. Lydekker's name on the title-page of this book, it is hardly necessary to say that the contents are brought right into line with the present state of knowledge of our mammals. The advances that have been made during the past twenty years, especially in regard to the geographical distribution of mammalia, are all given due consideration. The number of terrestrial mammals which are regarded as indigenous inhabitants of Great Britain during the historic period is forty-one, but five or six of these are now extinct. The poverty of Britain in species is shown by the fact that Germany possesses nearly ninety species and Scandinavia sixty. Various theories have been put forward in connection with this distribution. Whether the ancient British fauna was entirely swept away during the glacial period, or whether part of it survived in the South of England, and afterwards spread northward, is still an open question. In the former case it is necessary to believe that Britain was connected with the Continent after the glacial period; in the latter, no such connection need be considered. Mr. Lydekker says, "Whether, however, the one theory or the other of the re-population of England be adopted, we have to remember that the present impoverished mammalian fauna of Britain as compared with the Continent is due to the direct or indirect action of the glacial period, the effects of which have been so far-reaching both on inanimate and animate nature in the northern hemisphere." A section on the ancient mammals of Britain, which originally appeared in the columns of KNOWLEDGE, is included in the volume. There are thirty-two plates, none of which, however, call for special remark.

The volume dealing with the order Carnivora furnishes interesting reading on the characteristics and habits of those well-known animals comprehended under the title of cats, and including lions, tigers, leopards, pumas, tiger-cats, domestic cats, and lynxes. Besides the cats, the volume deals with those near relations, the civets and mangooses. The family *Felidæ*, however, is naturally treated in more detail, and a larger number of species are illustrated, than in the family *Liverridæ*. An account of fossil species forms the concluding section of the work. We think both volumes are very valuable additions to the series in which they appear.

*The Moon*. By T. Gwyn Elger, F.R.A.S. Pp. 173. (George Philip & Son.) 5s. Mr. Gwyn Elger ranks among the foremost selenographers, so this work of his may be relied upon as a trustworthy guide to the physical features of our satellite. All lunar objects of interest and importance are referred to, and, as might have been expected from an observer who has devoted his attention to lunar scenery for thirty years or so, their characteristics are truthfully described. A short history of observations of the moon, embodying a general account of the different kinds of formations observable, and statements of the speculations relating to lunar "geology," is contained in an introduction. Then comes the practical part of the book, and this is rendered exceedingly valuable by the fine map of the moon reproduced in four sections, each quadrant occupying a double page. This map is, without doubt, the clearest and most complete representation of the moon's surface available on the same scale, viz., eighteen inches to the moon's diameter. Taking each quadrant in turn, Mr. Elger describes all the interesting objects in them, and also a few features which, on account of their minuteness, could not be shown with any advantage on the map. Observers of the moon will find the volume meets all their requirements. The work is handy for reference, and is published at a reasonable price. It will doubtless become an indispensable companion to the telescope.

*The Theory of Light*. By Thomas Preston, M.A. Pp. 566. (Macmillan & Co.) 15s. net. This is a second edition of a work familiar to all physicists. The author aimed at producing "an accurate and connected account of the most important optical researches from the earliest times up to the most recent date," and those who are competent to judge know that he accomplished his purpose. The text of the new edition has been revised throughout, and more than one hundred pages of new matter have been added, as well as several new diagrams. These additions increase the value of a volume that has been regarded as a standard work on the theory of light ever since it first appeared.

XUM

*The Source and Mode of Solar Energy throughout the Universe.* By J. W. Heysinger, M.A., M.D. Pp. 361. (Philadelphia: J. B. Lippincott Co.) $2.00. So far as we understand the author of this volume, his theory is that electric currents are constantly passing through attenuated aqueous vapour between the sun and planets, and decomposing it into its constituents. Hydrogen is given off at the solar electrode and oxygen at the terrestrial or planetary electrode. We thus have an explanation, which may be left to our readers to assess at its proper value, of the preponderance of oxygen in our own atmosphere and of hydrogen in the sun. The electric currents required by the theory are supposed to be generated by the rotation and revolution of the planets, which are regarded as playing the part of electrical induction machines. Dr. Heysinger extends this fantastic idea to all astronomical phenomena, and uses it as a master-key to unlock, in a fashion, the caskets of celestial mysteries. In support of his views, he quotes copious descriptions from the works of eminent writers, few of whom, however, would care to give countenance to the curious theory in connection with which their writings are used.

*A Handbook of Systematic Botany.* By Dr. E. Warming. Translated by Prof. M. C. Potter, M.A., F.L.S. (Swan Sonnenschein & Co.) As a text-book of botany, this will take a high place, and as a handbook of reference it will prove valuable, though some of the lower groups of plants are but cursorily dealt with. The translation is from the third Danish edition of Prof. Warming's "Handbog i den Systematiske Botanik," and from Dr. Knoblanch's German edition. The order of treatment in the present volume is Thallophyta (subdivided into Myxomycetes, Algæ and Fungi), Muscineæ (Mosses), Pteriodophyta, Gymnospermæ and Angiospermæ. The Algæ and Fungi have been revised and rearranged in co-operation with Dr. Knoblanch. The sequence of orders in the Angiosperms, being that of the original Danish edition, will be unfamiliar to English students, but it possesses advantages over the more artificial system generally adopted. Prof. Potter states, in an appendix, the chief systems of classification of plants from Ray (1703) to Engler (1892), and shows how the artificial systems into which members of the vegetable kingdom have been arranged have gradually developed into natural systems, founded upon mutual relationships. The volume is richly illustrated, and is altogether a serviceable text-book for students of botany.

*The Elements of Botany.* By Francis Darwin, M.A., F.R.S. Pp. 235. (Cambridge: University Press.) Here we have a book which is a model of what an elementary science manual should be. The student who uses it will feel that he must see for himself the structures of the plants described, and personally verify the phenomena they illustrate. The fourteen chapters of the book contain the substance of the botanical lectures given to medical students in the course of elementary biology at Cambridge, and the practical work done in connection with the lectures is described in an appendix. Departing from the usual method, the author, instead of using a small number of species to illustrate the morphology, physiology, and natural history of plants, fixes on certain facts and phenomena, and selects a number of plants to exemplify them. Too great praise cannot be given to the numerous illustrations, which have mostly been drawn from Nature, and are far in advance of the stock figures that occur in so many text-books. Indeed, both text and illustrations are so attractive that the student who uses the book will certainly have a love of botanical knowledge developed in him.

*Crystallography; a Treatise on the Morphology of Crystals.* By Prof. N. Story Maskelyne, M.A., F.R.S. Pp. 521. (Clarendon Press.) 12s. 6d. Students of mineralogy have long waited for this volume, and have wondered whether the author would really complete his undertaking; and now the book has been published it fulfils the high expectations of all familiar with the work of the distinguished mineralogist who is responsible for it. The treatise deals solely with the morphology of crystals, that is to say, with the characters which result from the distribution and geometrical relations of their plane faces. It is a masterly exposition, in which the subject is treated in the simplest form compatible with strict geometrical methods. Students with a limited knowledge of mathematics will be able to comprehend some of the demonstrations, but the book appeals more to those who have had a high mathematical training. The volume undoubtedly ranks with the classical treatises on crystallography.

*Annual Report of the Board of Bequests of the Smithsonian Institution,* 1893. Pp. 762. (Washington: Government Printing Office.) Not only are the operations and condition of the Smithsonian Institution for the fiscal year ending June 30th, 1893, described in this report, there is also a general appendix comprising a miscellaneous selection of papers from various publications, and embracing a wide range of scientific investigation and discussion. Among these memoirs we notice one on "The Great Lunar Crater Tycho," by the late Mr. Ranyard, reprinted from KNOWLEDGE.

*Geometrical Conics.* By F. S. Macaulay, M.A. Pp. 260. (Cambridge University Press.) 4s. 6d. A well-constructed and fairly complete treatise on the elementary properties of conics, possessing clear descriptions, helpful illustrations, and numerous examples. The principles and methods employed are admirable. We commend the volume, which is extremely well printed, to the notice of all teachers and students of the subject with which it deals.

*Things New and Old; or, Stories from English History.* Standard VI. By H. O. Arnold-Foster. Pp. 248. (Cassell & Co.) To the many excellent school-books which Mr. Arnold-Foster has written must now be added this volume, dealing with the Stuart period of English history. Like the other volumes in the same series, this brings out the realities of history in a manner calculated to arouse interest in the minds of children. We are glad to see that such an event as the foundation of the Royal Society is not ignored, as it is in "drum and trumpet" histories generally, and that the works of such men as Newton and Harvey are not passed over in silence.

## BOOKS RECEIVED.

*Journal of the Franklin Institute for May,* 1895.

*First Principles of Chemistry.* By Samuel Cooke, M.A. (George Bell & Sons.) 2s. 6d.

*Students' Practical Chemistry Test Tables and Qualitative Analysis.* By Samuel Cooke, M.A. (George Bell & Sons.) 1s.

*First Principles of Astronomy.* By Samuel Cooke, M.A. (George Bell & Sons) 1s. 6d.

*Lessons in Elementary Physics.* By Balfour Stewart, M.A., &c. (Macmillan & Co.) 4s. 6d.

*Fingerprint Directories.* By Francis Galton, F.R.S. (Macmillan & Co.)

*Object Lessons in Botany.* Book II. By Edward Snelgrove, B.A. (Jarrold & Sons.) 3s. 6d.

*A First Book of Electricity and Magnetism.* By W. Perren Maycock, M.I.E.E. (Whittaker & Co.) 2s. 6d.

*Acoustics of Public Buildings.* By T. Roger Smith. (Crosby Lockwood & Son.) 1s 6d.

*Proceedings of the Academy of Natural Sciences, Philadelphia.*

*Diary of a Journey through Mongolia and Tibet.* By William Woodville Rockhill. (Smithsonian Institution.)

*Dairy Bacteriology* By Dr. Ed. Von Freudenreich. Translated by J. R. Ainsworth Davis, B A., &c. (Methuen & Co.) 2s. 6d.

*The Time Machine.* By H. G. Wells. (Heinemann.) 1s. 6d

*Petrology for Students.* By Alfred Harker, M.A., &c. 7s. 6d.

*A Text-Book of Zoogeography.* By Frank E. Beddard, M.A., &c. (Cambridge University Press.) 6s.

*Indexes to the Literatures of Cerium and Lanthanum.* By W. H. Magee, Ph.D. (Smithsonian Institution.)

*Memoirs of the British Astronomical Association; Report of the Section for the Observation of Mars.* By E. Walter Maunder, F.R.A.S.

## ON THE CAUSE OF EARTHQUAKES.

By Prof. J. LOGAN LOBLEY, F.G.S., &c.

IN a recent number of KNOWLEDGE I adduced evidence in support of the conclusion that the general climatal conditions of the globe in the Cambrian period were similar to those that now prevail on the surface of the earth.* But although this evidence is so abundant and cogent that the conclusion is inevitable and indisputable, yet its consequences are very generally overlooked, and it is frequently altogether ignored in the discussion of questions on which it has a direct bearing. Notably has this been the case in the discussion on the cause of earthquakes.

A connection between the cause of earthquakes and that of volcanoes is very generally assumed, and Mallet's dictum, that an earthquake is but an uncompleted volcano, is often quoted with tacit, if not expressed, acquiescence. This would seem to imply that both the cause of volcanic action and the cause of seismic action had been satisfactorily determined, and yet this is far from being the result of the long controversy on these two important questions.

Text-books usually give several theories to account for volcanic action, and while one hypothesis is on the whole favoured by one author, another receives the guarded assent of a second. The cause, or causes, of seismic phenomena are stated still more doubtfully, notwithstanding the mass of facts obtained by the laborious and prolonged investigations of Mallet, and the very valuable and more recent work of Prof. Milne in the seismic land of Japan.

There seems, however, to be a very prevalent opinion that a shrinkage of the so-called "earth's crust," consequent upon the secular cooling of the globe, is the primary cause of both earthquake and volcanic phenomena. Mallet not only attributed local earth-movements generally to the consequences of a gradual cooling of the globe, but derives volcanic heat also from the tangential pressure of the rocks of the crust by contraction following planetary cooling. What is precisely meant by the "earth's crust," and what the amount and rate of the cooling assumed, are not stated, and so the whole matter is left in a very vague and unsatisfactory position.

To the same shrinkage from planetary cooling is also ascribed the folding and contortion of rocks of all kinds and all ages, except those associated with intrusive igneous rocks, as well as the elevation of mountain chains and the vertical uprise and subsidence of areas both large and small. So repeatedly and so confidently is contraction from cooling stated as being the cause of such earth-movements, that it is generally accepted without question. Indeed, a shrinkage of the bulk of the earth is commonly regarded as required to account for the foldings and contortions of the surface rocks, and thus prove the point.

* "On the Climate of the Cambrian Period," KNOWLEDGE for November, 1894, p. 260.

More than fifty years ago, Sir Henry de la Beche wrote: "If we adopt the theory of a cooling globe, and the necessity of the solidified crust of one period, with its covering of sedimentary deposits, conforming to the reduced size of the earth at another, this solid crust, with its detrital covering, would be broken up, or wrinkled, or both, to conform to the new adjustment of parts." So confident did this truly great geologist appear to be that the theory of a cooling globe, with consequent shrinkage, was sound, that he did not think it necessary to state or suggest any other.

And although a thin hard crust with a great central fused mass has since been shown, by Lord Kelvin and other physicists and astronomers, to be incompatible with the proved rigidity of the globe, a settling down and accommodation of the crust to a shrunken central mass is still most confidently assumed. In a recent important work, the emission of lava is ascribed to its exudation from a central fused mass consequent upon the pressure of an exterior hard crust,† and in a still more recent text-book, earthquakes are attributed to, with other causes, "the snap of rocks that can no longer resist the strain to which, by the cooling and consequent contraction of the inner hot nucleus, they have been subjected within the earth's crust."‡

If, however, the general temperature at the surface of the globe was in Cambrian times similar to that of the present day, there can have been no appreciable amount of planetary cooling during the intervening period, and consequently no appreciable amount of contraction of the bulk of the globe, notwithstanding the enormous duration of the time that has elapsed since the Cambrian epoch. If, furthermore, there has been no appreciable contraction during this vast period of time, there cannot have been any contraction in a small unit of time, say a century to cause dislocation of surface rocks. But there is not merely an earthquake once a century, but without any exaggeration it may be said that, in one part of the world or another, there is at least one every week.

The report of the British Association on earthquakes (1851 to 1858) contains a catalogue of recorded earthquakes from B.C. 1606 to A.D. 1842, which, with the catalogue of Prof. Perry, of Dijon, from 1842 to the year 1850, gave between 6000 and 7000 earthquakes as having been recorded in 3456 years. But the following digest will clearly show that only in very recent times do the records of earthquakes at all approximately correspond with the number of occurrences:—

| | Annual Ratio. |
|---|---|
| From B.C. 2000 to B.C. 1000 ... ... | 0·004 |
| ,, B.C. 1001 ,, Christian era ... | 0·054 |
| ,, A.D. 1 ,, A.D. 1000 ... ... | 0·222 |
| ,, A.D. 1001 ,, A.D. 1850 ... ... | 7·740 |
| ,, A.D. 1551 ,, A.D. 1850 ... ... | 17·870 |
| ,, A.D. 1701 ,, A.D. 1850 ... ... | 35·310 |

When it is borne in mind that a great portion of the surface of the earth, to take only the land surface which is merely one-fourth of the whole, is sparsely peopled and without observers to record natural phenomena, it will be readily admitted that it is quite safe to conclude that the annual number of earthquakes between 1701 and 1850 as stated above is much below the fact. An earthquake a week may, therefore, be confidently assumed. Indeed, exactly double this number (104) were actually recorded by Prof. Fuchs as having occurred in 1876. In addition, however, to those violent disturbances that are

† "Geology," by Prof. Prestwich, p. 216.

‡ Geikie's "Class-book of Geology" (1883), p. 110.

designated earthquakes, there are the earth tremors and earth movements that can only be noted by the delicate seismograph. Disturbance of the exterior rocks of the globe, at one part or another of the earth's surface, must, therefore, be very frequently, it may be safe to say daily, taking place.

The conclusion, consequently, appears irresistible that the cause of earthquakes cannot, with a due regard to absolutely incontrovertible geological facts, be attributed to a contraction or shrinkage of the bulk of the globe, and that, therefore, another cause must be found.

Any cause, to be adequate for the production of constantly recurring phenomena, must be constantly operating and the result of forces continuously acting. So far as our present knowledge extends, there are but two classes of forces capable of disturbing the surface rocks of the globe. These are (1) physical and (2) chemical. By expansion and contraction consequent upon alteration of temperature, lateral pressure and lateral tension of incalculable intensity and power may be produced. By chemical action the requisite alteration of temperature to cause alteration of density, and consequently alteration of bulk, may be produced, to say nothing of the evolution of gases by decompositions and reactions. Again, chemical action may be checked and prevented or suppressed by excessive pressure, and stimulated or permitted by a diminution of pressure, and as lateral pressure lessens vertical pressure, increase of heat from slight chemical action, occasioning expansion and therefore lateral pressure, may be the cause of relief of vertical pressure, with the result of allowing more intense chemical action productive of greater heat and still greater expansion, with proportionally increased lateral pressure.

From these considerations it is obvious that physical and chemical forces act and react on each other, and in combination are capable of producing surface phenomena of great magnitude and importance, as well as of a minor character. Here, then, are forces constantly acting or potentially existing that are quite adequate to the production of seismic phenomena, without postulating the shrinkage of a thin crust over a fused interior mass that is alike opposed to the observations of astronomers, the calculations of physicists, and the facts of geology. It is true that the hypothesis of a solid nucleus with an intermediate ocean of fused matter between it and the solid exterior surface crust, as the source of lava, has recently received the support of eminent physicists; but this requires a mere thread of lava, dependent for its fluidity on a temperature rapidly lost, finding its way as a fluid through a thickness of thirty miles of solid, and therefore comparatively cool rocks, which certainly appears to be quite impossible.

In the early part of the century Sir Humphry Davy, after his discovery of the elements potassium and sodium and their violent combination with the oxygen of water, advanced a chemical theory to explain volcanic action, and, later, Dr. Daubeny also favoured a chemical hypothesis. These views have, however, been generally discarded as inadequate, but chemical forces and physical forces acting in conjunction appear to be amply sufficient to cause, not only seismic, but volcanic, action also.

In the year 1888, I brought before the British Association an hypothesis that seemed to me to account satisfactorily for volcanic action, and to meet the requirements of its observed phenomena.* By the hypothesis then explained and formulated, subterranean igneous conditions were attributed to chemical action when allowed by favouring physical conditions, prominent amongst which was diminution of pressure. To the same physio-chemical agency I attribute earthquakes, and earthquake shocks and tremors.

Earthquakes and earthquake shocks are not infrequent in the neighbourhood of active volcanoes, and minor tremors are common on volcanoes during and preceding eruptions. All such seismic phenomena are doubtless due to volcanic action, and, therefore, are primarily caused by what has produced that action. But the earthquakes of non-volcanic regions, which have their centres far away from any active vent, require a further explanation. They are caused, it appears to me, by the same chemical action that originates volcanic phenomena, but, acting with less intensity, it does not bring about rock-fusion, on which volcanic action depends. It is sufficient, however, to produce heat, gases and vapours with accompanying local expansions and succeeding contractions, and thus it occasions deep-seated and sudden fractures that give rise, from separate and distinct dynamic foci, to earth vibrations, which at the surface cause earthquakes, and earthquake shocks and tremors.

According to these views, seismic action and those of volcanic and plutonic origin have this in common, that they each originate from chemical action arising and developing from favouring physical conditions. When that action is sufficiently intense to create a rock-fusing heat, then either volcanic or plutonic results will follow; and when the heat produced at any one focus of chemical change, though considerable, is insufficient to fuse the adjacent rocks, an earthquake may be caused.

The sources of seismic, volcanic, and plutonic action will, therefore, be in a thin outer rind of the globe resting on an interior solid foundation, and unconnected with any fused central mass, and, consequently, with the exception of regions of fused rock near the exterior, the earth as a whole may be solid to the centre, and this would be quite in accordance with the rigidity our planet has been proved to possess.

* "On the Causes of Volcanic Action," Report of the British Association for 1888 (Bath meeting), p. 670; "Proceedings of the Geologists' Association," vol. xi., p. 1; "Mount Vesuvius," p. 212.

## THE EFFECTS OF LIGHTNING ON TREES.

THE effect of lightning on the oak and the beech is very different. As a rule, the effect of a lightning stroke on the oak tree is to split the trunk, or sever the large square-set branches. This is well exemplified in the accompanying illustration, reproduced from an excellent photograph kindly lent by Mr. H. J. Adams, of Beckenham.

The tree—originally a fine specimen, some fifty or sixty feet high, and absolutely sound—stood fairly isolated in a copse near Cobham in Kent. The whole of the crown was shattered, only about fifteen feet of the trunk and two of the lowermost branches being left. The bark, as the illustration shows, was entirely stripped from the trunk, which, though split down to the root, showed practically no signs of scorching.

The effect of lightning on a beech tree is not so apparent at the time, or even for long after. This is partly because the sappy branches of beeches are good water conductors, the water generally descending one side of the trunk, at least to a great extent, and the result is that the lightning follows the water, and scorches the bark down to the earth. The damage is frequently not visible on the surface of the bark till the spring following. In a year or two, however, the tree dies and becomes a picturesque ruin.

Kauschinger in his *Lehre vom Waldschutz*, following Hellman, calculates that if the liability of beech to be struck by lightning be assumed at 1, that for conifers is 15, oak 54, and for other broad-leaved species 40. Notwithstanding the isolated positions of thousands of oaks all over the country and in mixed forests, with their towering tops so "attractive" in a storm, no indigenous British tree

has withstood the attacks of so many terrific hurricanes and lightning-strokes as bravely as the oak. There are no humanly devised protective means against lightning in forests, and, for practical sylvi-cultural purposes, none are needed. Forest fires are extremely rarely, if ever, caused by lightning, and if a large tree is struck and severely damaged, no great loss is involved in clearing it away.

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The theory that the geological as well as the topographical conditions of certain localities "may have some influence upon the frequency of lightning stroke" was some time ago advanced by the meteorologist of the Royal Prussian Bureau of Statistics, to the effect that if 1 represents the frequency of lightning stroke in a chalk formation, 2 will represent the liability of marl, 7 for clay, 9 for sand, and 22 for loam. Amongst other popular fallacies, the following are successfully combated, namely: "That lightning never strikes the same place twice; that the most exposed position is always struck; that a few inches of glass or a few feet of air will serve as a competent insulator to bar the progress of a flash that has forced its way through a thousand feet of air."

* * * * *

From time to time, paragraphs get into press circulation (invariably *réchauffés* of ancient and well-worn legends) from the hands of one or other of our "most eminent popular scientists," about the fabulous ages of certain trees, particularly oaks. The fact is, that we have no means of knowing the exact, or even approximate, ages of trees of very old growth, except by inductively reasoning from the phenomena of tree *growth* in relation to time, and tree *decay*. The counting of rings does not serve as a guide after a certain time, and even during vigorous life, if cut down. Owing to unequal central development of growth, there may be found three or four times more rings on one side than another. Of course, when a tree reaches a great age and begins to gradually decay, the ring-counting process is no guide at all. For example, De Candolle records an instance of an oak felled in 1812, upon the trunk of which he managed to count seven hundred and ten distinct rings. That was proof to demonstration that the tree had lived seven hundred and ten years, but as De Candolle pointed out, it had probably lived for three hundred years longer than that problematical period "covering the remaining rings which it was no longer possible to count." Nor are the measurements of girths at stated periods of exact scientific value under all circumstances—in fact, they are utterly unreliable if they date back a hundred years or more. Perhaps the oldest oak in this country still showing signs of life is at Cowthorpe, in Yorkshire. It measures a fraction over seventy-eight feet in circumference, and is probably from one thousand five hundred to one thousand six hundred years of age. The great oak at Saintes, in France, is dead completely, its trunk having been scooped out and turned into a sort of arboreal tea room; but only a few years ago it had many signs of life, and measured a little over ninety feet in circumference. That oak probably lived close on two thousand years. Dr. Schlich, in his *Manual of Forestry* (Bradbury, Agnew & Co., Vol. I., pp. 168), referring to the disparity of timber-life generally, says that "if grown under conditions which are in harmony with their requirements," the yew lives more than one thousand years; the oak comes often near that age, "if it does not exceed it"; lime, elm, and sweet chestnut, about five hundred years; beech and silver fir, under favourable conditions, nearly the same; ash, maple, sycamore, spruce, larch, Scotch pine and hornbeam, three hundred years; and aspen, birch, alder and willow, rarely more than one hundred years.

* * * * *

Of course, in some respects trees never actually die; at least, that was Dr. Asa Gray's theory of arboreal life. "The tree," he wrote, "unlike the animal, is gradually developed by the successive addition of new parts. It annually renews not only its buds and leaves, but its wood and its roots—everything, indeed, that is concerned in its life and growth. . . . The old and central part of the trunk may, indeed, decay, but this is of little moment, so long as new layers are regularly formed at the circumference. The tree survives, and it is difficult to show that it is liable to death from age in any proper

sense of the term." A striking illustration of Dr. Gray's meaning may be seen in Kew Gardens any day, for there is flourishing there a branch offshoot of the great dragon tree of Orotava, Teneriffe, which was blown down in a terrific gale in 1868. That particular specimen of the genus *Liliaceæ* was of vast size and great age, an object of worship by the natives when discovered, fully five hundred years ago. When Humboldt visited the island in 1799, he found the tree seventy-five feet in height, fifty feet in girth, "with an internal cavity about ten feet in diameter." At the time of its destruction the tree was probably over two thousand years old, and must have weathered hundreds of terrific thunder-storms.

## THE CURE FOR SNAKE-BITES.

By Dr. J. G. McPHERSON, F.R.S.E.

PROFESSOR FRASER, of the University, has just laid before the Royal Society of Edinburgh the result of his experiments on snake-bites. For a quarter of a century Dr. Fraser has been one of the foremost authorities on toxicology, and this last discovery will be an inestimable boon to the dwellers in India, who are exposed to the poison of snakes.

The poison-gland of venomous snakes lies on each side behind the eye, and is about the size of an almond in the cobra. From this gland a duct extends to the base of the fang, down which the venomous juice flows when the snake bites its victim. By a muscular arrangement the poison-gland is automatically compressed when the snake opens its mouth to strike. But the opening of the mouth also brings about the erection of the fangs, which are recumbent when not used. The juice formed in the specialized glands and forced out along the fangs is a clear, viscid fluid, which may be kept for months or even years without losing its virulence. Injected through the fangs into the blood of a victim, it tends to paralyze the nerve-centres, and may prove fatal.

The extent of the mortality from snake-bite among inhabitants of warm countries is little known by Europeans; but in British India alone the deaths of persons reported from this cause varied from 18,670 in 1881 to 22,480 in 1889. During that decade rewards were paid for snakes destroyed to the number of 212,776 in 1880 to 578,415 in 1889; but this result is less satisfactory when it is known that in some places snakes are actually bred in order to secure the payment for their heads.

Many in India have been deceived with the idea that they have antidotes for snake-poison. In this country nearly every drug has been recommended—ammonia, permanganate of potash, arsenic, iodine, bromine, the poison of other snakes, the guaco plant, ipecacuanha, senega, aristolochia. But the distinguished authority on snake-poisons, Sir Joseph Fayrer, has no faith in any of these. Until Prof. Fraser's experiments have proved that he has hit upon the means of curing the victim, no reliable antidote was forthcoming.

The coloured charts and tables exhibited by Prof. Fraser showed the enormous amount of work which he has done in connection with the subject. He had great difficulty in getting a sufficient supply of venom to allow him to commence his experiments. He has been collecting for the last five years, and he has been getting it from India, Africa, America and Australia; but it was only at the end of last year that he had received enough to start with. The best of his supply has been sent from India. He showed some specimens dried and powdered and carefully sealed up in little bottles. It was peculiar-looking stuff, something like brown sugar, but not so sticky. His experiments, when completed, should give results which will be of great practical importance. He has proved that there is great *toleration* for snake-poison. This is his first successful discovery. Having ascertained the minimum dose required to cause the death of an animal, he started below that amount and gradually increased the dose after intervals of ten days. By this process of gradual increases in the dose of the snake-poison, he found the animal receiving as much at one time as fifty times the amount of the minimum lethal dose without it causing any bad effects to the animal. In fact its general health seemed to improve, as he had the animals weighed once and sometimes twice every day; and all the time he was administering the venom there was a steady increase in weight.

In the meantime, Prof. Fraser has not carried his experiments of quantity further than fifty times the minimum lethal dose at one time; but still, when he had got to that point, the animal was receiving in a single dose, without being affected, enough to kill fifty animals of the same size and weight. One of the animals which he had treated by this gradually increasing quantity, had, in two months, received enough poison to kill three hundred and seventy fresh animals of equal size and weight, supposing that each just got the minimum lethal dose. This is a very successful instance of toleration.

He then described a second series of experiments, in which he used the blood-serum of these animals, which had been immunized, as an antidote for the venom. He mixed an equal part of this blood-serum and venom together, and injected the mixture into a fresh animal. This produced no effect, the serum counteracting the action of the poison. Next, he injected some of the immunized blood-serum, which he has named *antivenine*, into a fresh animal; and then some venom afterwards; but the serum hindered any action of the venom. Then he took another fresh animal, and injected the venom, waiting till symptoms of poisoning were manifest; at once he injected his antivenine, and put a stop to any further progress of the poisoning. The same results took place after many experiments. All this points to the conclusion that this antivenine, or blood-serum, in an animal that has been able to stand with impunity fifty lethal doses at a time by the increasing dose process, is really an antidote to the poison of snakes.

Prof. Fraser is at present immunizing a horse, but he has not enough venom to finish the work. He has only got nine grammes, and still requires thirty; but the Indian Government is trying hard to secure it for him. This he expects to receive before long. When the horse has been immunized, he expects to get enough antivenine from its blood-serum to allow of its being tested chemically, so as to ascertain the substances which antagonize the venom. In this way it is hoped, the ingredients being known, the antivenine can be chemically prepared.

This discovery will be of great practical importance, for the antivenine can be prepared and sent out to India in small bottles for immediate use in the case of snake-bites. But, even as it is, the discovery of antivenine itself is a most valuable one, and gives evidence of the great advance made in medicine during recent years, when the thyroid preparation for myxœdema and the antitoxin for diphtheria, and such like, have startled the medical world. The attempt made by the Indian Government to clear out snakes, by payment of so much for a snake's head, will evidently be less successful than the extirpation of wolves in Wales by a similar method; for the fact is, that the number of snakes is really increasing. It is to the antivenine which Prof. Fraser will be able to prepare by

chemical processes, after ascertaining the ingredients in the immunized blood-serum, that the people of India must look for the proper antidote in cases of snake poisoning. There would be sufficient time to administer the anti-venine, as death does not ensue until from three to twenty-four hours after a bite.

At the close Prof. Rutherford, the celebrated physiologist and experimentalist, stated that he had never listened to such a lucid account of a series of experiments, and he was very glad that it was in Edinburgh University that such a valuable discovery had been made.

## ORGANIC MATTER AND WATER FILTERS.

DR. S. RIDEAL recently discussed in KNOWLEDGE the objects and methods of the filtration of large waterworks. As he pointed out, it is now clearly known that the capacity of water to cause disease depends directly, not on its chemical but on its bacterial contents. The danger of pathogenic organisms lies essentially in the enormous rapidity with which they grow under favourable conditions. The circumstances in the composition of water which assist or repress the growth of organisms have not yet been definitely worked out; but it is certain that temperature, bacterial and even mechanical contents, and chemical composition have a more or less defined influence. Accordingly, in the criticism of a supply proposed for a large town, chemical analysis is a factor of which account must be taken, and as more definite results are obtained connecting variations of chemical composition with alterations in the capacity of an organism to develop, such analysis will for this purpose have an increasing value. In the case, however, of domestic filters, the importance of chemical analysis becomes considerably less, as the water will be kept for a relatively short time after filtration, and the increase of organisms, either through their growth in transit or through the accidental pollution of the supply in the pipes, will already have taken place. In the examination of a domestic or industrial water filter, it is therefore usually immaterial to determine whether or not any chemical alteration has occurred in the water during filtration. This circumstance to some extent simplifies the task of examining the water filter, but entails the necessity of entirely reconsidering the data which hitherto have been taken as relevant in the construction of such filters. For many years before any positive connection was established between typhoid fever and a specific micro-organism, it was established that this and other diseases were in some way connected with the composition of the drinking water previously consumed by the patient. By chemical analysis it was found that in almost all cases of such diseases the water contained an excess of organic matter, and when a water supply with less organic matter was substituted for that which had been connected with an epidemic, the disease invariably disappeared. It was accordingly considered a reasonable inference to regard the organic matter as being at the root of the disease, and its removal as a sufficient sanitary precaution. The presence of excess of organic matter in dangerous waters was due to the larger capacity of such substances to support the life and favour the growth of the specific micro-organisms, and the filters, still largely in use, which arrested such organic matter are thus seen to furnish a culture-bed of concentrated nutrient value for such disease organisms as may occur in the water. Accordingly, when such a filter is tested with polluted water for a few days, it is found that the filtrate is much richer in micro-organisms than the unfiltered water. If subsequently sterile water be passed through it, the filtrate may come out teeming with microbes. At the same time such filters are, in fact, found to be incapable of preventing the direct passage of micro-organisms, and accordingly, both by permitting them to pass directly into the filtrate and by multiplying those which are retained, they are now known to be dangerous to health.

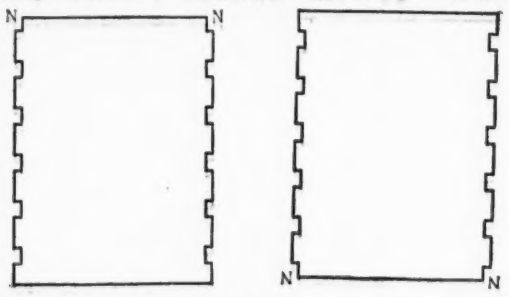
These facts have recently been verified by examinations of all known types of filters by Dr. Sims Woodhead and Dr. Wood, at the Research Laboratory of the Colleges of Physicians and Surgeons, and by a very minute examination of representative filters made at the Public Health Laboratory of the University of Edinburgh by Dr. Johnston. These researches confirm entirely earlier results obtained by Continental investigators, beginning with M. Pasteur, who in 1878 stated to the Academy of Sciences that no material had yet been discovered capable of arresting micro-organisms. There can be no question but that such results have demonstrated conclusively the worthlessness and the danger of the filters which they condemn. It is doubtful whether any practicable laboratory experiment can, in the present state of knowledge, warrant the efficiency of a filter; the difficulty being that, in the absence of a definite relation established between the composition of water and the source of organisms on the one hand, and the conditions favourable to the development of organisms which apparently are necessary for an epidemic on the other, it is almost impossible to be certain of reproducing in laboratory examination the conditions which occur in actual practice during epidemics. Probably, therefore, the course which for the present must be taken in the examination of water filters proposed as sufficient for the prevention of water-borne disease, is to simultaneously examine them under identical conditions with some filter of which the efficiency has been independently established. Up to now the only filter in regard to which adequate practical evidence is available is that of Pasteur. It was applied some seven or eight years ago to those quarters in the French army in France, Algeria, Tunis, etc., where the water supply was most polluted or suspicious, and the civil population were subject to endemic or epidemic typhoid fever. The total number of quarters so fitted is 245,000. The results of the application of this filter are necessarily derived from a very large number of independent health returns, which are only collated at head-quarters, and therefore cannot be vitiated by personal bias or error. The area over which the experiment, if it may be so called, was conducted includes so large a variety of climate and water conditions, and the period of observation was so long, that any result common to the whole of the installations may be stated in general terms as characteristic of the appliances; while the constant presence of a civil population not furnished with the filters would have constituted a current control-experiment, by which the results of coincidence could at once be eliminated, even if the scale of the observations, both in point of number and of extent in time, had been insufficient to do so. In other words, the experience derived from this enormous use of a single type of appliance, in the circumstances disclosed, gives a reliable basis for a strict induction. The result of the experiments is expressed in the reports of M. de Freycinet while Minister of War from 1889 to 1892, in which, after tracing a continuous decrease of typhoid fever in every year, he finally reports that in every case where the Pasteur filter had been applied, even in districts previously the most attacked, typhoid fever had disappeared. General Zurlinden, the present Minister of War, published in April a further report on the same subject, not only showing an increased

reduction of the amount of typhoid in the army, the present number of cases being considerably less than half of that which existed at the beginning of the experiment, but also examining the figures of some thirty of the principal garrisons which had in earlier years been the most affected by typhoid fever. The result of this examination is to show in detail the accuracy of the general statement made by M. de Freycinet in 1892; the conclusions being in many cases checked by the re-appearance of the disease immediately, through any cause, the use of the filters was discontinued. General Zurlinden, in fact, shows that such cases of typhoid as occurred, and must in an army of half a million of men be always inevitable, are either contracted externally at bars, inns, and the like, or have resulted from the accidental contamination of some water supply, previously regarded as sufficiently pure to be used without Pasteur filtration.

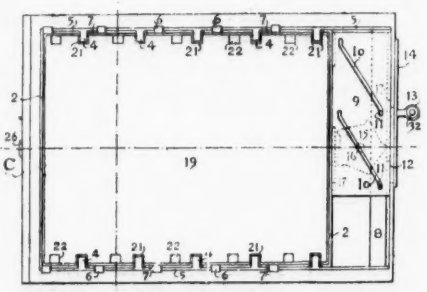
Similar results have been worked out in special cases by independent medical observers; and the Pasteur filter may accordingly be taken as a reliable and convenient standard for the efficiency which is necessary to prevent water-borne disease. Any filter which, tested simultaneously and under identical conditions with micro-organisms furnished experimentally with artificial assistance to growth exceeding that which will occur in ordinary water, offers for a sufficient time the same resistance as does the Pasteur, may at once be taken to give the same efficiency of filtration. Any filter which does not must be condemned, unless evidence be forthcoming to show that the efficiency of the Pasteur filter exceeds that which is necessary for the prevention of disease. An unfortunate instance of the results which are liable to occur through the use of inadequate filters came out recently in the House of Commons, where the Minister representing the War Office stated that an epidemic of cholera which occurred last year at Lucknow had been now traced by a special committee, appointed by the Government of India, to the pollution of the barrack-room filter. This epidemic had been confined to the troops of the East Lancashire regiment, which used this particular filter. The strength of the regiment at the time was six hundred, out of whom one hundred and forty were attacked and ninety—or nearly one man out of every six in the regiment—died.

## Some Recent Patents.

Joseph Thacher Clarke, Boston, Mass., U.S.A. Improvements in or relating to apparatus for the exposure, separation, and storing of a pack or series of photographic films. This invention consists in an arrangement by means of which a pack of sensitized films, or like flexible sheets, may be exposed in connection with an ordinary photographic camera, and may thereafter be transferred *seriatim* to a light-tight receptacle, where they are stored in another pack or series. The edges of the films are notched, as shown in Fig. 1. In making

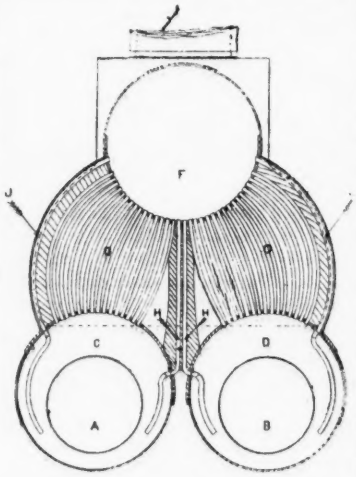



up the films into a pack, an alternate sequence is maintained as regards the position of these notches. The front of the magazine is provided along its sides with two series of projecting teeth. Upon these teeth the films are supported. 9 (shown in Fig. 2) is a push plate, which is pierced by two diagonal slots 10, 10, in which play two pins 11, 11, projecting from the cross-bar 8. A lobe of the push plate 9 projects through a slot 12 in the casing, and is fitted with a handle 13. By sliding the handle 13 to and fro in the slot, the film-changing mechanism may be operated from the outside of the case. The films are thereby released alternately, and allowed to fall from the magazine into the receiver. (The Frena Film Holder. R. & J. Beck, London.)




*No.* 2566. *Dated 6th February*, 1893. *Five figures.*

Charles Scott Galloway, Glasgow. Improvements in steam boilers. This is a combination steam boiler. In the figure, which is a transverse sectional elevation, A and B are two furnaces formed to the required shape to fit into the shells or water-jackets C and D. The furnaces are not concentric with the shells or water-jackets, but are placed below the centre, making the space between the top of the furnace and the shell or water-jacket the minimum required for a man to go inside and expand the tubes. G G are circulating water tubes externally heated. F is the steam and water drum. The products of combustion travel through the furnace tubes A B, then pass up the back,




coming forward among the tubes G, and upwards to the flue. J J are walls of non-conducting material.

*No.* 19,913. *Dated 19th October*, 1894. *Accepted 24th May*, 1895. *Two figures.*

## THE FACE OF THE SKY FOR JULY.

By HERBERT SADLER, F.R.A.S.

BOTH sunspots and faculæ show but little decrease in either number or magnitude. Conveniently observable minima of Algol occur at 11h. 48m. P.M. on the 3rd, at 8h. 37m. P.M. on the 6th, and at 10h. 19m. P.M. on the 26th.

Mercury is invisible during the first half of the month, being in inferior conjunction with the Sun on the 1st. After that he becomes a morning star, rising on the 16th at 2h. 57m. A.M., or 1h. 6m. before the Sun, with a northern declination of 19° 48′, and an apparent diameter of 9·0″, about $\frac{2}{10}$ths of the disc being illuminated. On the 21st he rises at 2h. 45m. A.M., or 1h. 24m. before the Sun, with a northern declination of 20° 45′, and an apparent diameter of $7\frac{3}{4}''$, $\frac{34}{100}$ths of the disc being illuminated. He is at his greatest western elongation (19° 55′) on the 23rd. On the 26th he rises at 2h. 41m. A.M., or 1h. 34m. before the Sun, with a northern declination of 21° 28′, and an apparent diameter of $6\frac{3}{4}''$, nearly half the disc being illuminated. On the 31st he rises at 2h. 51m. A.M., or 1h.

34m. before the Sun, with a northern declination of 21° 34′, and an apparent diameter of 6·0″, nearly $\frac{7}{10}$ths of the disc being illuminated. While visible he describes a direct path through Gemini, being near the 4th magnitude star ζ Geminorum on the 22nd and 23rd.

Venus is an evening star, and is a fine object in the western sky. She sets on the 1st at 10h. 32m. P.M., with a northern declination of 14° 37′, and an apparent diameter of 21$\frac{1}{2}$″, nearly half the disc being illuminated. On the 10th she sets at 10h. 10m. P.M., or 1h. 57m. after the Sun, with a northern declination of 10° 52′, and an apparent diameter of 23$\frac{3}{4}$″, just half the disc being illuminated. She is at her greatest eastern elongation (45$\frac{1}{2}$°) on the 11th. On the 20th she sets at 9h. 41m. P.M., or 1h. 37m. after the Sun, with a northern declination of 6° 30′, and an apparent diameter of 26$\frac{1}{2}$″, $\frac{44}{100}$ths of the disc being illuminated. On the 31st she sets at 9h. 3m. P.M., or 1h. 16m. after the Sun, with a northern declination of 1° 43′, and an apparent diameter of 30$\frac{1}{2}$″, $\frac{36}{100}$ths of the disc being illuminated. During the month she describes a direct path through Leo.

Mars is, for the observer's purposes, invisible.

The minor planet Juno is in opposition to the Sun on the 11th, her magnitude at the present opposition being about equal to that of a 9th magnitude star. On the 9th she transits at 0h. 10m. A.M., with a southern declination of 4° 42′. On the 20th she transits at 11h. 14m. P.M., with a southern declination of 5° 22′. On the 31st she transits at 10h. 21m. P.M., with a southern declination of 6° 16′. At transit on the 10th she is 16s. *p* and 52′ north of the 5$\frac{1}{4}$ magnitude star *f* (26) Aquilæ, and 2s. *p* and 2$\frac{3}{4}$′ south of the 7th magnitude star B.D.—4°, 4781. At 8h. 30m. P.M. on the 27th she is in conjunction with the 3rd magnitude star λ Aquilæ, 52′ to the south. She pursues a retrograde path through Aquila during July.

Jupiter is in conjunction with the Sun on the 10th.

Saturn is an evening star, and is fairly well placed for observation. He rises on the 1st at 2h. 8m. P.M., with a southern declination of 9° 18′, and an apparent equatorial diameter of 17$\frac{3}{4}$″ (the major axis of the ring-system being 40$\frac{3}{4}$″ in diameter, and the minor 11$\frac{1}{2}$″). On the 10th he sets at 0h. 4m. A.M., with a southern declination of 9° 21′, and an apparent equatorial diameter of 17$\frac{1}{2}$″ (the major axis of the ring-system being 40·1″ in diameter, and the minor 11$\frac{1}{4}$″). On the 20th he sets at 11h. 20m. P.M., with a southern declination of 9° 27′, and an apparent equatorial diameter of 17$\frac{1}{4}$″ (the major axis of the ring-system being 39$\frac{1}{2}$″ in diameter, and the minor 11$\frac{1}{4}$″). On the 30th Saturn sets at 10h. 41m. P.M., with a southern declination of 9° 37′, and an apparent equatorial diameter of 16$\frac{3}{4}$″ (the major axis of the ring-system being 38″ in diameter, and the minor 11$\frac{1}{4}$″). Saturn is almost stationary during July in Virgo.

Uranus is an evening star, but should be looked for as soon after sunset as possible. He sets on the 1st at 0h. 54m. A.M., with a southern declination of 16° 21′, and an apparent diameter of 3·7″. On the 30th he sets at 11h. 0m. P.M., with a southern declination of 16° 17′. He is almost stationary in Libra during July.

Shooting stars are fairly numerous in July, though the twilight interferes with observation. A well-marked shower radiates from near δ Aquarii, the maximum being on the 28th. The radiant point is in R.A. 22h. 40m.—13° 0′.

The Moon is full at 11h. 29m. P.M. on the 6th; enters her last quarter at 8h. 31m. A.M. on the 15th; is new at 5h. 32m. A.M. on the 22nd; and enters her first quarter at 8h. 36m. P.M. on the 28th. She will be in apogee at 7h. A.M. on the 11th (distance from the earth 251,780 miles); and in perigee at 1h. P.M. on the 23rd (distance from the earth 223,620 miles).

## Chess Column.

By C. D. Locock, B.A.Oxon.

Communications for this column should be addressed to C. D. Locock, Burwash, Sussex, and posted on or before the 12th of each month.

*Solutions of June Problems.*

(A. C. Challenger.)

No. 1.

1. K to K2, and mates next move.

Correct Solutions received from G. G. Beazley, Alpha, W. Willby, J. T. W. Claridge, H. S. Brandreth, F. V. Louis, A. Louis, E. W. Brook, and J. T. Blakemore.

No. 2.

Key-move.—1. Q to KKt7.

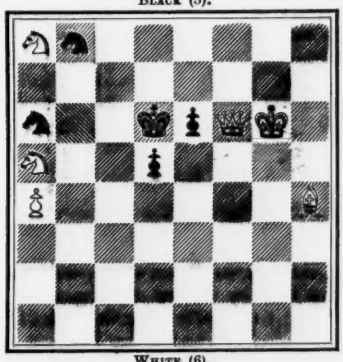
1. . . . K to Q3. 2. B to B4, etc.
1. . . . K to Q4. 2. B to B4 ch, etc.
1. . . . K to B4. 2. B to Kt4ch, etc.
1. . . . Bishop moves. 2. B to B4ch, etc.

Correct Solutions received from Alpha, H. S. Brandreth, E. W. Brook, A. Louis, F. V. Louis, W. Willby, and J. T. Blakemore.

PROBLEM.

By C. D. Locock.

Black (5).



White (6).

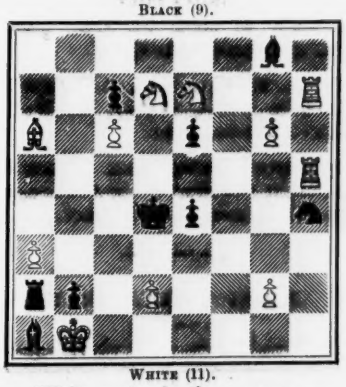
White mates in two moves.

We give below the first prize problem in the three-move section of the tournament in connection with the *Manchester Weekly Times*. It should be remarked that competitors were debarred from the use of the White Queen.

By A. F. Mackenzie, Jamaica.

First Prize.

Black (9).



White (11).

White mates in three moves.

The following game obtained the brilliancy prize in the recent tournament of the New Jersey Chess Association:—

"Ruy Lopez."

| J. Lissner. WHITE. | I. S. Loyd. BLACK. |
|---|---|
| 1. P to K4 | 1. P to K4 |
| 2. Kt to KB3 | 2. Kt to QB3 |
| 3. B to QKt5 | 3. P to Q3 |
| 4. P to Q4 | 4. P × P (*a*) |
| 5. Castles | 5. B to Q2 |
| 6. P to QB3 (*b*) | 6. P × QBP |
| 7. Kt × P | 7. Kt to K4 ? |
| 8. Kt × Kt | 8. P × Kt |
| 9. Q to Q5 | 9. P to QB3 |
| 10. Q × KPch | 10. Q to K2 |
| 11. Q to KKt3 (*c*) | 11. P × B |
| 12. Kt to Q5 | 12. Q to QB4 |
| 13. Kt to B7ch (*d*) | 13. K to Qsq |
| 14. Kt × R | 14. Q to QBsq |
| 15. B to K3 | 15. Q × Kt |
| 16. KR to Qsq | 16. P to QKt3 (*e*) |
| 17. Q to KKt5ch ! | 17. Kt to KB3 (*f*) |
| 18. P to K5 | 18. P to KR3 |
| 19. Q to KR4 | 19. P to KKt4 |
| 20. B × KKtP | 20. R to Ktsq |
| 21. B × Ktch | 21. K to Ksq |
| 22. P to KKt3 | 22. R to Kt5 |
| 23. R × B ! (*g*) | 23. R × Q |
| 24. QR to Qsq | 24. B to K2 |
| 25. R × Bch | 25. K to Bsq |
| 26. KR to Q7 | 26. K to Ktsq |
| 27. R to Q8ch | 27. Resigns. |

NOTES.

(*a*) 4. . . . B to Q2 is the more usual and better continuation.

(*b*) The sacrifice of the Pawn is probably not sound, but White obtains thereby a free development. It will be seen that Black practically abandons the Pawn on his seventh move, probably overlooking White's ninth move.

(*c*) A very brilliant idea, more especially as it is not forced in any way.

(*d*) It would seem that White could gain a move here by 13. B to K3 (*vide* his fifteenth move). This would have shortened the game considerably.

(*e*) Black has no time for this manœuvre. It is a question even whether he should have wasted two moves with his Queen in order to take the Knight. Now, at any rate, he should attempt to bring his other pieces into play, perhaps by Kt to K2 and Kt to QB3.

(*f*) If 17 . . . K to Ksq, then 18. R × B. Or if 17. . . . P to B3, 18. Q to Kt4, Q to Bsq; 19. R × B, etc. But 17. . . . Kt to K2 looks better.

(*g*) A very pretty finishing touch. Apart from his thirteenth move, White's conduct of the attack against a rather weak defence is both sound and brilliant.

## CHESS INTELLIGENCE.

The International Tournament, which begins at Hastings on August 5th, promises to be an unprecedented success. The prizes are large and the entries likely to be both numerous and important. Among other likely competitors may be mentioned Steinitz, Lasker, Tarrasch, Lipke, Blackburne, Bird, Mason, Teichmann, Marco, Burn, Pillsbury, Mieses, etc. Only five games will be played a week by each player, so that a tournament of twenty-one competitors will last exactly four weeks, even if there is no tie for the first prize to be played off. Probably the Committee will be under the painful necessity of refusing many entries, for it is hardly likely that more than twenty-one will be wanted; possibly even sixteen would be considered a more desirable number, though more than that number are sure to enter.

Simultaneously with the above a minor tournament, open to the world, will also be held. The British player who comes out highest will hold the Newnes Challenge Cup, which carries with it the title of Amateur Champion of the British Chess Association, a title which has been in abeyance for the last four or five years.

The match at the British Chess Club between Blackburne and Von Bardeleben was finally given up as drawn, after each player had scored three games, with three games drawn. Herr von Bardeleben's stay in England being limited, and the days of play somewhat indefinite, the premature division of the stakes was not altogether unexpected. Probably both players were satisfied with the result, for though the English champion started well, his opponent was gradually getting into practice.

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TWO PLATES.—1, Greek Coins; 2, Photographs of Maurolycus and Albategnius.

## *NOTICES.*

The numbers of KNOWLEDGE for January and February of last year can now be had, price One Shilling each.

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